

Revision of the Trochinae, tribe Trochini (Gastropoda: Trochidae) of southern Africa

by

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ABSTRACT

All species of the tribe Trochini known to occur in southern Africa are discussed (ten species, one new, belonging to three genera). Observations on external anatomy and radula morphology are given for nine of the ten species.

New species: *Clanculus natalensis*.

New synonyms: *Polydonta (Infundibulum) concinnum* A. Adams, 1855 and *Trochus (Infundibulum) baccatus* Sowerby, 1889 = *Trochus cariniferus* Beck in Reeve, 1842; *Clanculus laceyi* Sowerby, 1889 = *Clanculus miniatus* (Anton, 1838).

Lectotypes designated and figured: *Clanculus carinatus* A. Adams, 1852; *Clanculus waltonae* Sowerby, 1892; *Clanculus mixtus* Smith, 1903; *Clanculus elevatus* Turton, 1932; *Clanculus trochiformis* Turton, 1932; *Polydonta (Infundibulum) concinnum* A. Adams, 1855; *Trochus nigropunctatus* Reeve, 1861; *Trochus (Infundibulum) baccatus* Sowerby, 1889.

Neotypes designated and figured: *Trochus cariniferus* Beck in Reeve, 1842; *Trochus flosculus* Fischer, 1878; *Trochus miniatus* Anton, 1838.

Holotypes figured: *Clanculus alfredensis* Bartsch, 1915; *Clanculus atricatena* Tomlin, 1921; *Clanculus becki* Turton, 1932; *Clanculus eucosmia* Turton, 1932; *Clanculus kowiensis* Turton, 1932; *Clanculus laceyi* Sowerby, 1889; *Trochus textilis* Reeve, 1861.

Type locality emended: *Monodonta punicea* Philippi, 1846.

Type localities designated: *Trochus cariniferus* Beck in Reeve, 1842; *Trochus miniatus* Anton, 1838.

Type species designated: *Trochus mauritianus* Gmelin, 1791, is designated type species of *Pyramidea* Swainson, 1840, making the latter an objective synonym of *Tectus* Montfort, 1810.

INTRODUCTION

Hickman & McLean (1990) enlarged the subfamily Trochinae to include the Gibbulinae and Monodontinae of previous classifications (eg. Wenz 1938, Moore 1960) and their proposals are accepted herein. Nevertheless, within this subfamily, members of the old Trochinae, now treated as the tribe Trochini, comprise a relatively well-defined entity with comparatively distinct shell characters, most notably the disjunction of the columella and paries. The only extant genera currently referred to the tribe are *Trochus*, *Tectus*, *Clanculus* and three New Zealand taxa of uncertain rank, *Coelotrochus* Fischer, 1879, *Thorista* Iredale, 1915 and *Thoristella* Iredale, 1915.

Barnard (1963) provided the only revisionary work so far published on southern African representatives of this group, but the value of his work was severely limited due to the small amount of material upon which it was based, and the lack of illustrations. Since then a great deal more material has been obtained including an undescribed species.

MATERIALS AND METHODS

The material examined during the course of this study has been acquired by various means. That of intertidal species has been built up during the course of many years of institutional field-work. Dredging undertaken by the staff of the Natal Museum has provided much additional material including undescribed species and live-taken specimens of subtidal species previously known only from dead shells. The majority of specimens of tropical species have been collected during my SCUBA diving field-work in Zululand.

Protoconch diameter was measured as previously described (Herbert 1987). Radulae were dissected out, macerated in dilute NaOH, sonicated briefly, air-dried via alcohol and mounted on stubs using double-sided tape. Gold-coated specimens were examined at low accelerating voltage (5 kv) in an Hitachi S-570 scanning electron microscope.

For the purposes of this revision, southern Africa is defined as that part of the African continent lying south of an west-east line drawn between the mouth of the Kunene River (the border between Namibia and Angola) and the mouth of the Limpopo River (Mozambique).

The terminology for apertural dentition used in diagnoses and descriptions pertaining to species of *Clanculus* is illustrated in Fig. 1. This figure is a composite, designed to show features of apertural dentition typical of *Clanculus*, but is not representative of any one species in particular.

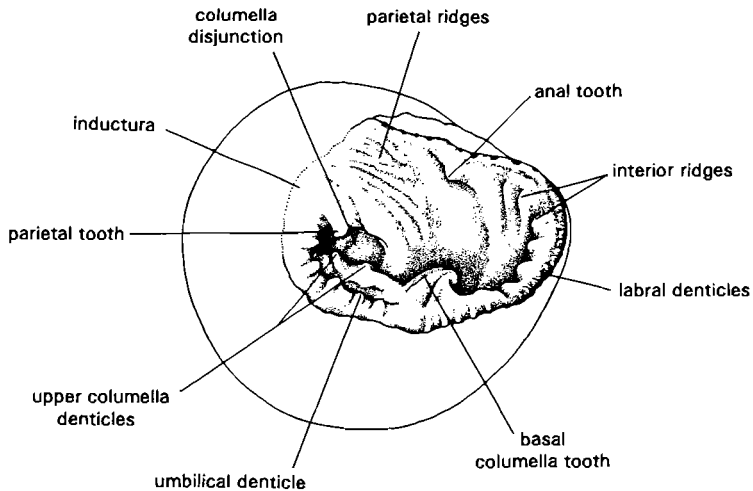


Fig. 1. Composite drawing of apertural features of *Clanculus* species to illustrate terminology used in subsequent diagnoses and descriptions.

MORPHOLOGY

Protoconch

Overall protoconch morphology within the Trochini is typically trochoidean and relatively conservative. Little variation is shown amongst southern African

representatives of the tribe. In all species examined herein the protoconch is small (diameter 180–260 μm) and paucispiral (± 1.25 whorls). The terminal lip is sinuous, being somewhat angled (convex) approximately mid-way between the upper and lower sutures. There is no subterminal varix, although a slight constriction immediately prior to the terminal lip is frequently evident. The protoconch apex is weakly beaked in *Clanculus*, somewhat more strongly so in *Trochus*. The surface of the protoconch appears smooth in all southern African species, but Bandel (1982: pl. 7, fig. 6) figured very fine superficial sculpture in his *Trochus* cf. *sandwichensis*. It is probable that such sculpture would be worn away in all but the freshest specimens. The bicarinate shell with coarsely sculptured protoconch illustrated by Bandel (1982: pl. 5, figs 3, 6) as *Trochus* [= *Tectus*] *dentatus* Forsskål, 1775, has much more the appearance of a juvenile *Turbo*.

This combination of protoconch character states (a sinuous terminal lip, a weak, but distinct apical beak, the lack of obvious sculpture, and the lack of a varix, but presence of a slight subterminal constriction) may yet prove to be of value in supraspecific classification. Its consistency throughout the Trochini/Trochinae merits further investigation.

Radula

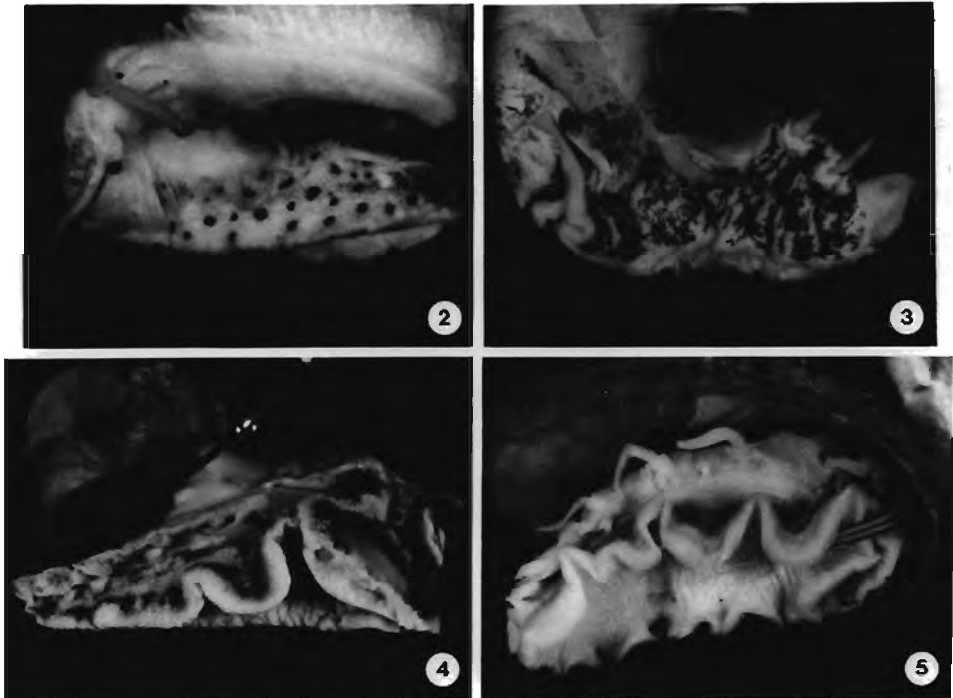
Radula form and variation within the tribe Trochini has been discussed by Hickman & McLean (1990). A formula of $\infty + 5 + 1 + 5 + \infty$ is the norm and the cusps of all teeth remain well developed. In southern African species there appear to be three styles of radula dentition. Firstly, in genera such as *Trochus* and *Tectus* the rachidian and laterals show a relatively complex form of basal interaction in which an expansion on the outer side of one tooth fits into a corresponding socket on the median aspect of its outer neighbour. This is most pronounced in *Tectus virgatus* and has been illustrated also in *Tectus fenestratus* (Gmelin, 1791) (Troschel 1879, pl. 22, fig. 2).

The remaining two styles, found in *Clanculus*, are more similar to each other and exhibit what is evidently a relatively simple overlap of tooth shafts/base-plates in the central field; they differ in the form and proportions of the rachidian. In the Cape endemic species, here tentatively placed in *Clanculopsis*, the cusp of the rachidian is comparatively broad, approximately half the width of the widest part of the base-plate; this is also evident in the figure of the radula of the type species of *Clanculopsis*, *C. cruciatus* (Linnaeus, 1758), given by Troschel (1879, pl. 22, fig. 7, as *C. vieillotii* Payr.). In species referred to *Clanculus* s. s. the rachidian cusp is narrower, usually only one third the width of the base-plate (see also Herbert 1993). These differences are consistent for all local *Clanculus* taxa for which the radula is known. Within the subgenera interspecific variation in radula morphology would seem to be small.

Anatomy (Figs 2–5)

The early literature provides some simple figures of living animals of various species referable to this tribe (eg. Adams & Adams 1853–58) and occasional brief descriptions (eg. Fischer 1887). Apart from isolated observations (eg. Gofas 1984), modern literature has added little further comparative anatomical data. For a group

with so many conspicuous littoral species this is surprising, but is doubtless due to the group being restricted for the most part to the Indo-West Pacific. Many new and useful anatomical observations were recently provided by Hickman & McLean (1990), but no detailed comparative studies have yet been published.



Figs 2–5. External anatomy of examples of southern African Trochini. 2, *Clanculus puniceus*, length of foot = 11,5 mm; 3, *Clanculus miniatus*, length of foot = 7,5 mm; 4, *Trochus nigropunctatus*, length of foot = 19,0 mm; 5, *Trochus cariniferus*, length of foot = 9,5 mm.

It is evident that little specialisation has occurred in terms of the external anatomy of the tribe and, in fact, the Trochinae as a whole, particularly when compared to other trochid subfamilies such as the Solariellinae and Umboniinae (Herbert 1987 1992). Indeed the external anatomy of the Trochinae is probably little derived from the ancestral trochoidean condition. Notable features of the external anatomy of the tribe include well-developed cephalic lappets, neck lobes of similar form, prominent papillation of the epipodial fold and sides of the foot, and the development of papillate hoods over the epipodial sense organs (Figs 2 & 4). Members of the Cantharidini have a much less well-developed pedal and epipodial papillation and, though the two neck lobes may be similar to each other (or even the same), the free margin is frequently smooth. They also usually (not invariably, cf. *Alcyna* in Hickman & McLean 1990: fig. 62b) have only three pairs of epipodial tentacles compared to four in the Trochini. Members of the Gibbulini, like the Cantharidini, have a less strongly papillate head-foot complex and tend to have distinctly

dimorphic neck lobes, the free margin of the left one digitate, that of the right one entire. Species of *Clanculus* have a well-defined, sometimes differentially coloured, slit-like groove lined by what appears to be a glandular epithelium, lying longitudinally on the dorsal surface of the posterior part of the foot, behind the operculum. A similar, transversely ridged and possibly glandular epithelium is present in this region in many other trochoidean genera, but its limits are rather poorly defined. The function of this gland merits further study, particularly with regard to the shell-cleaning observations made by Jones (1984) (see remarks under *Trochus nigropunctatus*).

Also noteworthy is the pigmentation of the external epithelium, in particular, that of the tentacles. In many gibbuline and cantharidine taxa the tentacles are patterned with distinct transverse bands (rings) of black and/or white. I have not observed this in any of the live-taken material of south-western Indian Ocean Trochini that has been available to me. These instead possess uniformly coloured tentacles or tentacles with dark longitudinal stripes, most noticeable on the cephalic tentacles (Figs 4–5; see also Hickman & McLean, 1990: fig. 56). In many species of *Clanculus*, particularly *Clanculus s. s.*, the pigmentation of the body closely resembles that of the shell, not only in respect of the hues involved, but also in the pattern in which the pigment is distributed.

The operculum is of the corneous, multispiral, planorboid type, typical of trochids. The surface is smooth, whorl overlap is small and the peripheral fringe is very narrow and not radially striate (cf. Umboniinae). The growing margin is narrow, but in some genera, eg. *Clanculus*, opercular growth ceases with the development of the adult apertural dentition, when shell growth also presumably ceases. At this stage the growing margin tapers off and the operculum becomes evenly rounded (Figs 44–45).

The ctenidium is bipectinate almost throughout, only the posterior one eighth being monopectinate, and the afferent ctenidial membrane is long, extending well beyond the junction of the transverse pallial vessel, leaving less than one quarter of the ctenidium free anteriorly.

BIOLOGY

Members of the Trochini are predominantly inhabitants of hard substrata in shallow water and many are common in the intertidal zone, particularly in tropical regions. The bathymetric range of southern African species lies for the most part at depths of less than 50 m. Only *Clanculus natalensis* sp. n. and *C. waltonae* Sowerby, 1892, have been found living at depths greater than this, but even these are restricted to the continental shelf (<200 m).

The only member of the tribe studied to any extent from a biological view point has been the commercially important *Tectus niloticus* (Linnaeus, 1767) (see Rao 1937 and Heslinga 1981 for references). There is no published information regarding the biology of southern African species except a suggestion that *Trochus nigropunctatus* feeds on the leaves of *Cymodocea* [= *Thalassodendron*] (Macnae & Kalk 1969). However, it is probable that this observation actually relates to *Jujubinus suarezensis* (Fischer, 1878).

In the tribe as a whole, as with most vetigastropods, feeding is presumably primarily detritivorous and/or herbivorous. Eisawy (1970) stated that *T. dentatus*

feeds on algae rasped from rocks and boulders and Rao (1937) reported, from analysis of gut contents, that *T. niloticus* feeds mainly on algae browsed off the substratum, but noted also that the gut contained much inorganic debris and the remains of a wide range of animal taxa ingested with the algal material. A similar, rather indiscriminate, browsing of superficial algal growth is probably practised by most members of the group and perhaps by larger trochoideans in general, but this remains to be further investigated.

The sexes are separate, but there is no reported sexual dimorphism in shell morphology. Fertilisation is external and two patterns of larval development have been reported (Eisawy 1970). In the first, male and female spawning is synchronised and the gametes are shed directly into the sea, the fertilised eggs hatching to release free-swimming trochophore larvae. This has been recorded in *Tectus dentatus* (Eisawy 1970) and *T. niloticus* (Heslinga 1981). In the second group, containing for example *Trochus erithreus* (= *erythraeus* auctt, but original spelling = *erithreus*), the eggs are deposited in gelatinous masses attached to solid objects and hatch as free-swimming veligers (Gohar & Eisawy 1963). Similar variation in spawning and development occurs in many (probably most) supraspecific trochoidean taxa (Hickman 1992).

Larval development is lecithotrophic and involves a planktonic stage in all species so far studied, with the exception of *Clanculus bertheloti* (d'Orbigny, 1839) (see below). Development as a whole is rapid, amongst the fastest within the Trochoidea (Hickman 1992). *Tectus niloticus* hatches as a trochophore 12 hrs after fertilisation and progresses, in the presence of inducing algae, through settlement and metamorphosis in as little as three days from fertilisation (Heslinga 1981). A relatively short time is thus spent in the plankton and the potential for dispersal is consequently reduced. This fact may well account for the surprisingly restricted distributions of many species within the tribe. Growth of *T. niloticus* subsequent to settlement was discussed by Honma (1988).

In *Clanculus bertheloti* the eggs are brooded, by both males and females, in the interstices between the coarsely granular spiral cords on the shell exterior (Thorson 1967). Development is non-planktonic and the young leave the parental shell as crawling juveniles. This is the only documented observation on spawning and larval development in the genus *Clanculus* of which I am aware. However, this is almost certainly an extreme case and the majority of *Clanculus* species will doubtless prove to have a more conventional trochoidean mode of development, involving a free-swimming, lecithotrophic phase.

ZOOGEOGRAPHY

In southern Africa there are two elements in the composition of the Trochini fauna, firstly warm temperate to subtropical endemics and secondly, tropical Indian Ocean incursives whose ranges extend into Zululand and Natal. Even the latter, however, are for the most part endemic to East Africa and the islands of the western Indian Ocean. No members of the tribe are currently known from the colder waters of the Atlantic Cape, although two extinct species of *Clanculus* have been described from raised beach deposits on the Namaqualand coast, *C. murrayi* Carrington & Kensley, 1969, and *C. lutosus* Kensley & Pether, 1986. These inhabited the area during

warmer periods in the Late Pliocene and Early Pleistocene (Carrington & Kensley 1969, Kensley & Pether 1986). The former is clearly related to the endemic Cape species *C. miniatus* (Anton, 1838). The most southerly extant species recorded off West Africa are *C. santamariae* and *C. pseudocorallinus* described by Gofas (1984) from southern Angola.

Species of *Trochus* are common in the Indian Ocean, but only two have been collected south of northern Mozambique, namely *T. cariniferus* (a tropical East African endemic) and *T. nigropunctatus* (a subtropical south-east African endemic). Nearly all species of *Clanculus* occurring in Natal and Zululand belong to *Clanculus s. s.*, *C. puniceus* and *C. flosculus* are tropical incursives, whilst *C. atricatena* and *C. natalensis* are subtropical Natal/Transkei endemics, but both the latter clearly have affinities with the warm water component rather than the colder Cape element. Three species of *Clanculus*, here placed in the subgenus *Clanculopsis*, occur in the Cape Province. Of these only *C. mixtus* has a distribution extending into Natal.

Tectus virgatus is the most widespread member of the tribe occurring in southern Africa, having a tropical distribution extending to the eastern Indian Ocean and perhaps into the western Pacific.

TAXONOMY

Family: Trochidae Rafinesque-Schmaltz, 1815

Subfamily: Trochinae Rafinesque-Schmaltz, 1815

Tribe: Trochini Rafinesque-Schmaltz, 1815

Hickman & McLean (1990), in dividing the subfamily Trochinae into three tribes, have provided a suprageneric framework for the classification of this difficult group of trochids. Three genera within the tribe Trochini are represented in southern Africa.

Key to genera and subgenera of Trochini in southern Africa

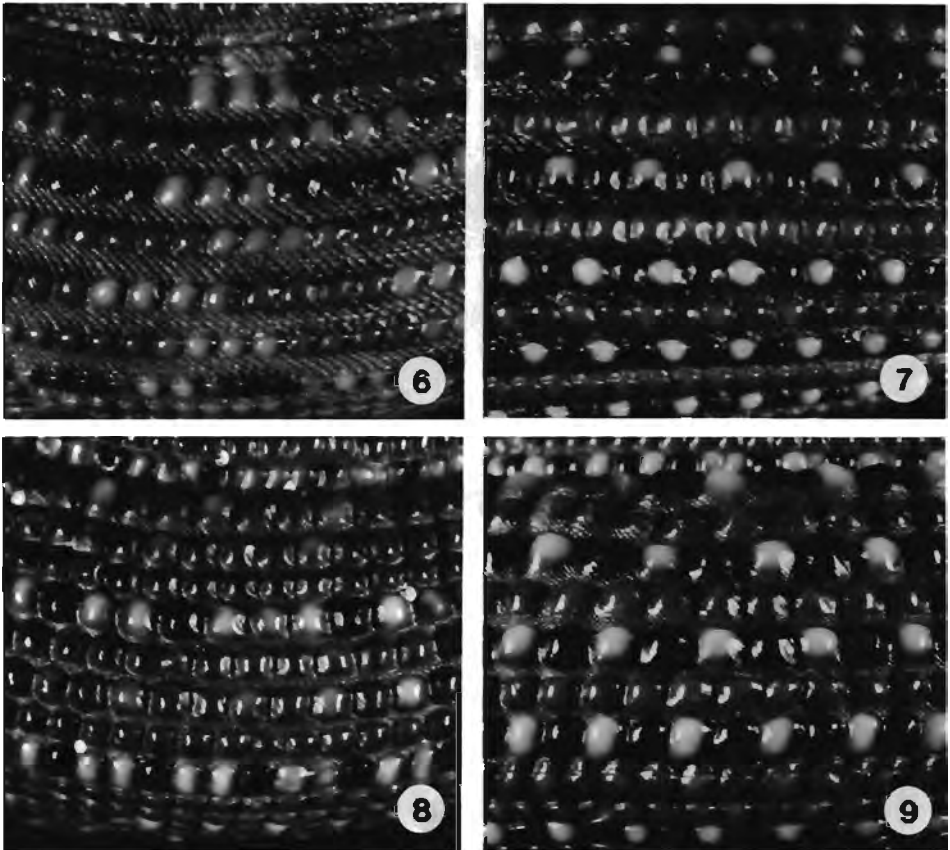
- | | | |
|---|---|---------------------------------|
| 1 | Shell umbilicate* | 2 |
| – | Shell anomphalous | Tectus |
| 2 | Shell with denticulate aperture, simple or complex; sutures impressed | Clanculus 3 |
| – | Shell without denticulate aperture, or if denticulate then sutures not impressed and shell more or less conical | Trochus 4 |
| 3 | Apertural dentition well developed; basal columella tooth large and compound (ie. sculptured with two or more ridges) | Clanculus s.s. |
| – | Apertural dentition relatively poorly developed; basal columella tooth small and simple (ie. sculptured with at most one ridge) | Clanculus (Clanculopsis) |
| 4 | Umbilicus with spiral cords which render columella denticulate; columella strongly angled below parietal disjunction | Trochus s.s. |
| – | Umbilicus without spiral cords; columella smooth and not strongly angled below parietal disjunction | Trochus (Infundibulops) |

* The term pseudoumbilicus or pseudumbilicus is often used in connection with this group of trochids. I have not used this term because the umbilicus, when present, even when lined with callus, is still the true umbilicus.

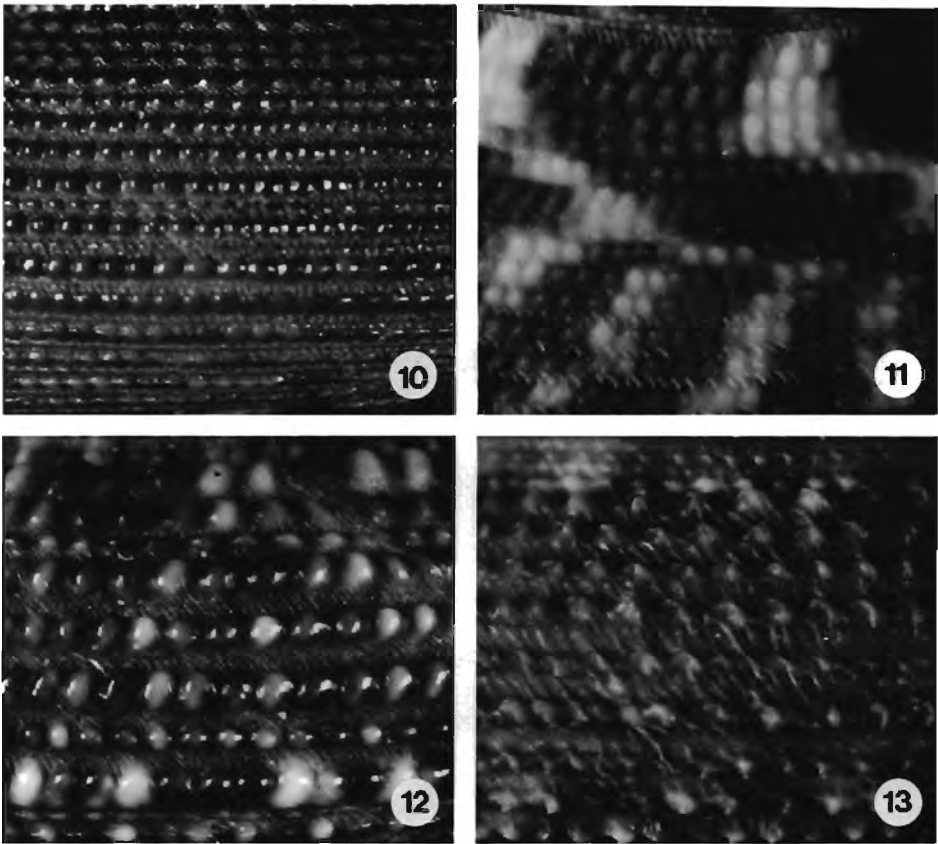
Excluded taxa

'*Trochus punctatus* Mus. Berol.' recorded from South Africa by Krauss (1848: 98)(*per* Philippi) and subsequently renamed *Trochus troschelii* by Philippi (1850, in 1846–55) is in fact *Thalotia conica* (Gray, 1827) (Pilsbry 1889, Cotton 1959), from South Australia and was erroneously localised to South Africa.

Clanculus exquisita Turton, 1932: 180, described from Port Alfred, is a juvenile of *Calliostoma africanum* Bartsch, 1915. *Clanculus kraussii* (Philippi, 1846), recorded from Durban (Sowerby 1897), does not occur in southern Africa (see remarks under *C. atricatena*). *Trochus textilis* Reeve, 1861, was wrongly localised to the Cape of Good Hope and is not part of the southern African fauna (see remarks under *T. nigropunctatus*).



Figs 6–9. Sculptural details of *Clanculus* species; the area shown is almost the entire width of the apical surface of the body whorl in the dorsal region. 6, *C. atricatena*; 7, *C. flosculus*; 8, *C. puniceus*; 9, *C. pharaonius*.



Figs 10–13. Sculptural details of *Clanculus* species; the area shown is almost the entire width of the apical surface of the body whorl in the dorsal region. 10, *C. natalensis*; 11, *C. miniatus*; 12, *C. mixtus*; 13, *C. waltonae*.

Clanculus Montfort, 1810

Clanculus Montfort, 1810: 191. Type species (by o.d. *fide* Marshall, 1979) *Trochus pharaonius* Linnaeus, 1758.

Clangulus Blainville, 1817: 354 (err. pro *Clanculus*)

Otavia Risso, 1826: 132.

Fragella Swainson, 1840: 220, 352. Type species (o.d. p220), "the strawberry trochus" = *Trochus pharaonius* Linnaeus, 1758, (see for example Wood 1828: 141), the first species listed on p352).

I consider the division of *Clanculus* into subgenera to be a highly subjective procedure. I have found it impossible to provide definitive diagnoses for the currently available names (see Keen in Moore 1960); exceptions and intermediate stages with respect to one or more characters can always be found. Nonetheless some subdivision of the genus is helpful and can serve to group similar species together and thus suggest closer phylogenetic relationships even though these cannot be defined categorically. I have assigned the southern African *Clanculus* species to two subgenera, *Clanculus s.s.* and *Clanculopsis* Monterosato, 1879. In the following subgeneric diagnoses I mention characters that can be taken as the norm for a given subgenus, but not the absolute rule.

Some of the most useful characters for species determination in *Clanculus* concern details of sculpture (such as the width of the spiral cords relative to the cord intervals, the strength of the granulation and the presence/absence of intermediary axial pliculae) and colour pattern. For comparative purposes, such details are illustrated in Figs 6–13 for all local species and for the type species. The figures show the apical surface of the dorsal portion of the body whorl.

Key to species of *Clanculus* in southern Africa.

- 1 Apertural dentition well developed, basal columella tooth compound (ie. sculptured with two or more ridges); uppermost ridge on interior of outer lip enlarged to form a distinct anal tooth (not *natalensis* sp. n.) 2
- Apertural dentition relatively poorly developed, basal columella tooth small and simple (ie. sculptured with at most one ridge); uppermost ridge on interior of outer lip not enlarged 5
- 2 Colour pattern with black (or dark) dots or dashes 3
- Colour pattern lacking dark dots or dashes **natalensis**
- 3 Shell small (adult diameter <14,0 mm), relatively elevated (L/D 0,88–1,15); colour pattern usually comprising spiral cords of alternating black and white granules, these in turn alternating with uniform orange-red cords **flosculus**
- Shell larger (adult diameter usually >15,0 mm), less elevated (L/D 0,75–1,05); colour pattern more uniform, black/dark markings restricted to two rows of dots or dashes on the apical surface of each whorl and two similar rows on the base 4
- 4 Overall shell colour a relatively uniform orange-red to vivid red, with occasional paler granules **puniceus**
- Overall shell colour brown to pinkish-brown, somewhat mottled **atricatena**
- 5 Shell trochiform, distinctly angled at periphery, sometimes carinate; suture not channelled; adult diameter frequently >15,0 mm **miniatus**
- Whorls more rounded, periphery below mid-whorl, but not distinctly angled; suture channelled; adult diameter <13,0 mm 6
- 6 Sculpture of coarse spiral cords and lamellate axial pliculae; spiral cords with scale-like prosocline granules; intervals between cords frequently deep **waltonae**
- Sculpture of spiral cords beset with rounded granules; orientation of granules orthocline or opisthocline, not prosocline; intervals between cords shallower, sculptured by fine close-set, non-lamellate, prosocline pliculae **mixtus**

Subgenus *Clanculus* s. s.

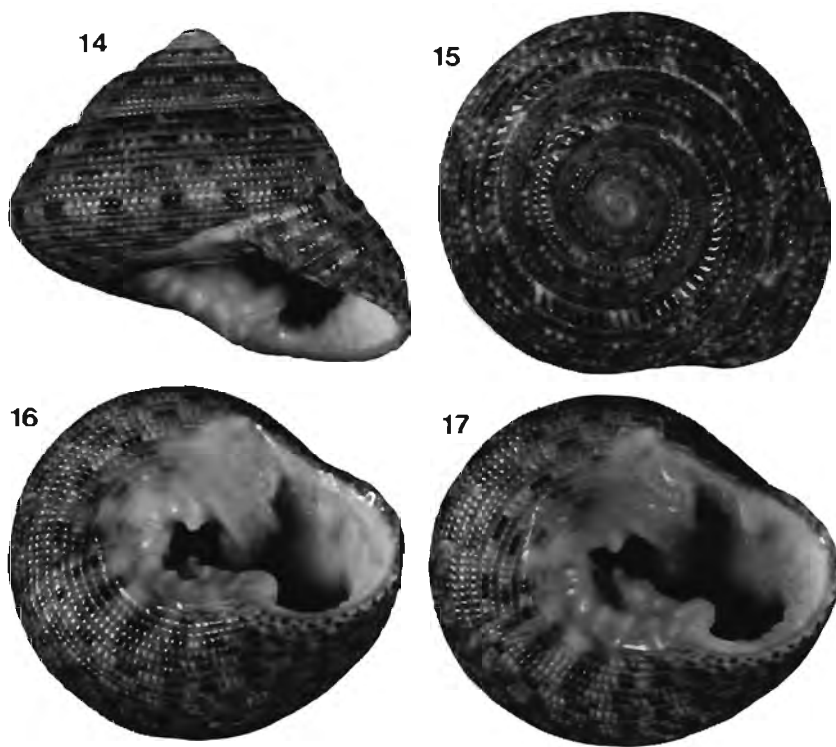
Diagnosis: Basal columella tooth compound (ie. with more than one raised ridge); uppermost ridge on interior of outer lip enlarged to form an anal tooth (some exceptions); apertural dentition well developed, parietal ridges usually strong; umbilicus deep. Rachidian tooth of radula with cusp less than half width of shaft/base-plate.

Clanculus (Clanculus) atricatena Tomlin, 1921

Pl. 1d, Figs 6, 14–19.

Clanculus puniceus (partim) Krauss, 1848: 100, N° 20.*Clanculus kraussi* [sic] (non Philippi, 1846); Sowerby, 1897: 19.*Clanculus atricatena* Tomlin, 1921: 216; Barnard, 1963: 247; Kensley, 1973: 36, N° 70; Kaicher, 1980: 2184; Springsteen, 1981: 4, fig. 5; Kilburn & Rippey, 1982: 40, pl. 8, fig. 6. Type loc.: Durban.

Diagnosis: Shell moderate to large, pinkish-greyish-brown to greyish-brown; two spiral cords on adapical surface articulated with black and near-white markings; profile trochoid-turbiniform, sutures weakly indented and not channelled; periphery more or less rounded; spiral cords relatively fine, on apical surface their width equal to or narrower than that of intervals, sculptured with fine granules; cord intervals with close-set, prosocline axial pliculae; apertural dentition well developed, basal columella tooth compound, anal tooth present; umbilicus deep, open virtually to apex.

Figs 14–17. *Clanculus atricatena* Tomlin, 1921; holotype, length 13,5 mm, diameter 16,1 mm.

Description: Shell trochoid-turbiniform ($L/D = 0,75-0,90$); teleoconch of up to 7 whorls, whorls somewhat adpressed, sutures weakly indented, not channelled; spire whorls conoid to coeloconoid (when unworn), becoming cyrtconoid on penultimate and body whorls; last part of body whorl in mature shells descends noticeably near

aperture, the outer lip joining penultimate whorl well below periphery; periphery below mid-whorl, more or less evenly rounded; base somewhat flattened, umbilicate. First teleoconch whorl with three spiral cords, one at shoulder, one at periphery and one between these; upper and lower cords become patterned with deep pink to crimson spots (dashes) during second whorl (very similar to *puniceus*), middle spiral occasionally with similar dots; upper and lower cords become black-articulated cords of later whorls; intermediary spiral cords arise with growth, body whorl with 6–11 cords between suture and periphery; three primary spiral cords of early teleoconch whorl sometimes remaining stronger than others during subsequent whorls, but more frequently not; subsutural cord of later whorls frequently wider than remaining cords, uppermost portion of subsutural cord sometimes further divided by finer cords; 1–2 cords between subsutural cord and upper articulated cord, 3–7 between upper and peripheral articulated cords. All spiral cords granular from an early stage; granules roundly quadrate to trapezoid, relatively fine and close-set (Fig. 6); orientation of granules variable, opisthocline, orthocline or prosocline and subject to considerable inter- and intra-individual variation, but orientation of granules on a given spiral cord usually consistent; subsutural cord for the most part with larger, somewhat flattened, axially elongate, prosocline granules, but becoming irregularly plicate on last part of body whorl. Intervals between cords relatively wide (equal to or wider than width of cords) and sculptured by close-set, prosocline, axial pliculae and occasional spiral lirae (Fig. 6). Base more finely sculptured with 15–20 close-set, granular cords; cords somewhat broader, and granules flat-topped and more obviously quadrate/rectangular toward umbilicus; intervals between cords narrow, occasionally with fine intermediary lirae. Umbilicus open almost to apex, surrounded by inductural callus; mature apertural dentition well developed; umbilicus bordered by 4–6 (usually 5) ridge-like denticles; parietal tooth present, size variable, but usually prominent; parietal ridges present, that nearest parietal tooth fold-like; interior of outer lip with spirally aligned, ridge-like denticles, the uppermost of which is considerably larger and forms a well-developed anal tooth; edge of outer lip with black markings and sometimes weak labral denticles at ends of external spiral cords, denticles usually disjunct from interior ridges; basal columella tooth prominent and compound, sculptured by 2–3 ridges; columella strongly reflected, frequently with 1–2 small denticles in the central portion; upper columella denticles well developed, separated by a wide notch; disjunction between columella and paries deep-set; interior nacreous when fresh, but iridescence lost in most museum material.

Protoconch: Diameter *ca* 240–260 μm , ± 1.25 whorls; translucent yellowish-white; worn in all available specimens.

Colour: Apical whorls translucent, suffused with pink/orangish-pink, becoming pinkish-brown to light greyish-brown/moderate brown with growth; most spiral cords weakly articulated with groups of paler (whitish) granules, usually more noticeable on the subsutural cord; two cords (see above) boldly articulated with black and pale brownish-white, one at or near periphery, the other between this and suture; black markings mostly covering 2–3 granules, pale ones covering 4–5 granules (Fig. 6); very occasionally a third cord, lying between these, also articulated with black. Base similarly patterned, but paler markings usually predominate towards umbilicus; two, occasionally three cords articulated with black; position of articulated cords relative to other cords

variable, but one frequently close to umbilical margin. Umbilicus and aperture white to very pale brownish-white; outer lip with black spots at the ends of the spiral cords.

Dimensions: Largest NMSA specimen, length 15,7 mm, diameter 17,7 mm; smallest specimen with mature apertural dentition, length 10,5 mm, diameter 13,2 mm.

Operculum: Corneous; multispiral with a central nucleus, orange-brown to smoky-brown; outer face smooth and glossy.

Radula (Fig. 18): Very similar to that of *C. puniceus*, but cusps of rachidian and laterals somewhat more elongate and more sharply rounded; rachidian more deeply indented in the mid-line.

External anatomy: As in *C. puniceus*, but coloration brownish rather than red. A very

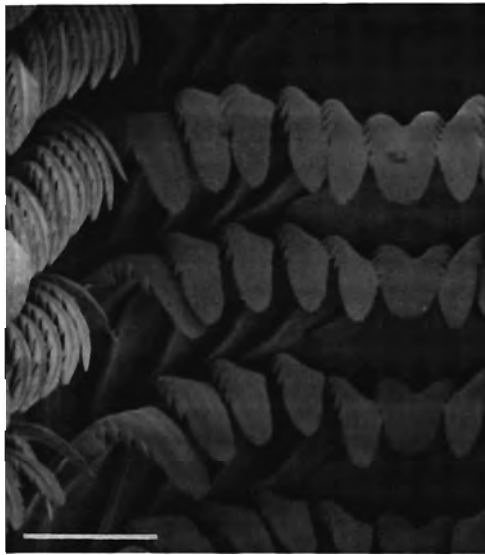


Fig. 18. *Clanculus atricatena* Tomlin, 1921; portion of radula, ex NMSA S3614, bar = 100 μ m.

small right post-optic tentacle is present in the only specimen available.

Distribution (Fig. 19): Northern Zululand to central Transkei; LWST and shallow subtidal reefs; very rarely found alive, but not uncommonly washed ashore, particularly in southern Natal and north-eastern Transkei. It is possible that the range of the species extends into Mozambique and a single specimen (NMSA H3993) from Conducia Bay, northern Mozambique, is perhaps referable here.

Locality data (all NMSA): ZULULAND: Mission Rocks/Perrier Rocks, littoral, RK & DH, (D5581); off Port Durnford, 20 m, rocks, medium brown sand, dredged NMDP (D8226). NATAL: Nonoti, H. Burnup (A6344); Durban, W. Falcon, H. Burnup, J. Quekett (6358, 6360, 8371 living, 8900); Durban south beach, in reclamation sand dredged off Durban Bluff, 20–22 m, RK & R. Fregona (B5446); Durban, Vetch's Pier,

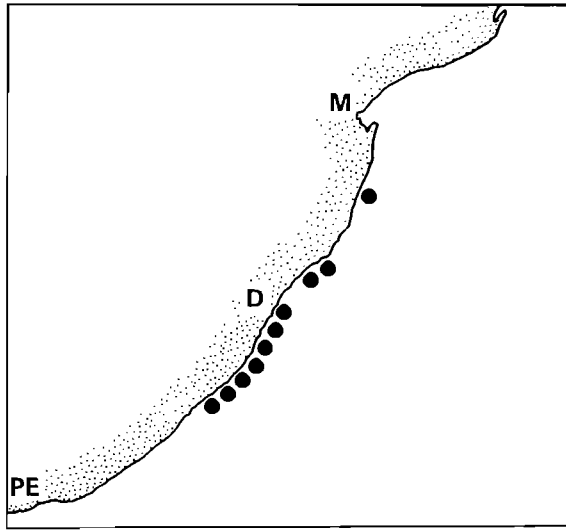


Fig. 19. Map showing distribution of *Clanculus atricatena* Tomlin, 1921; each black circle represents one or more records. M = Maputo; D = Durban; PE = Port Elizabeth.

J. Marais (S3754); Brighton Beach, B. J. Young coll'n (B2244); Treasure Beach near Reunion Rocks, T. Stewart (E8487); Reunion Rocks, B. J. Young coll'n (B2239); Reunion Rocks, intertidal rocks and pools, living, J. Marais (S3694, S3761)); Scottburgh, H. Burnup (6355); Kelso, H. Burnup (6352); Port Shepstone, H. Burnup (6354); Shelly Beach near Izotsha, RK, J. Marais, W. Rump, N. Watt (9043, A4568, S3762, D5439); Uvongo, J. Marais (S3765); Palm Beach, R. & E. Kilburn, J. Marais (A1549, S3766); TRANSKEI: Mzamba, beach drift, RK, DH & R. Fregona, J. Marais (B4496, D2985, S3755, S8351); between Mzamba and Mtentu rivers, J. Stannard (E5987); Mtentu River mouth, J. Marais (S3763); Mgwetyana River area, Mkambati, RK *et al.* (C5594); Msikaba Island, RK *et al.* (B4946, C5583); Port Grosvenor, rock pools, LWST, RK & J. McKay (B927); Mbotyi, beach drift, RK & DH (C8264); Pondoland coast, A. Filmer (B1126), identified by Sowerby III as *C. kraussii* (Philippi); Lwandile/Mdumbi area north of Whale Rock, E. Kilburn (C42).

Type material: The holotype of *Clanculus atricatena* Tomlin, 1921 (Figs 14–17) is in the NMWC (1955.158.961), together with five paratypes (1955.158.1176). Holotype dimensions, length 13,5 mm, diameter 16,1 mm.

Remarks: The identity of this species remained problematic until its description as a new taxon by Tomlin (1921). Krauss (1848) noted that he had material from Natal (two juvenile specimens) which was separable from *C. puniceus*, but did not name it. Sowerby III later recorded the West African *C. kraussii* (Philippi, 1846) from Durban (Sowerby 1897), but his material was almost certainly *C. atricatena*. There are further specimens of *C. atricatena* in the NMSA collected by Agnes Filmer and sent to Sowerby by H. Becker which were returned to Becker identified, in Sowerby's

hand, as *C. kraussii*. This record of *C. kraussii* from south-eastern Africa was repeated by Nicklés (1950), but must certainly be rejected.

C. atricatena most closely resembles *C. puniceus*, but is brown (rather than red), has a distinctly pink-tinged apex, finer sculpture with wider intervals between the spiral cords and is generally smaller (max. diameter <18,0 mm). Furthermore, the black marks on the spiral cords are more elongate, usually encompassing 2–3 granules (mostly 1–2 in *puniceus*), and are separated by intervals of 3–5 paler granules. The juvenile stages of both species are extremely similar. *C. largillierti* (Philippi, 1849) from the Mascarene Islands, is darker brown in colour, has white (pale) subsutural blotches and lacks axial pliculae in the cord intervals (Herbert 1993).

Etymology: *Atri*-, from *ater* (L.) – black, and *catena* (L.) f. – a chain; referring to the articulated spiral cords.

Clanculus (Clanculus) flosculus (Fischer, 1878)

Pl. 1c, Figs 7, 20–26.

Trochus flosculus Fischer, 1878: 211; *idem*, 1878 (in 1875–80): 300, pl. 96, fig. 1; Pilsbry, 1889: 67, pl. 11, figs 56, 57; Sheppard, 1984: 46. Type loc.: Seychelles.

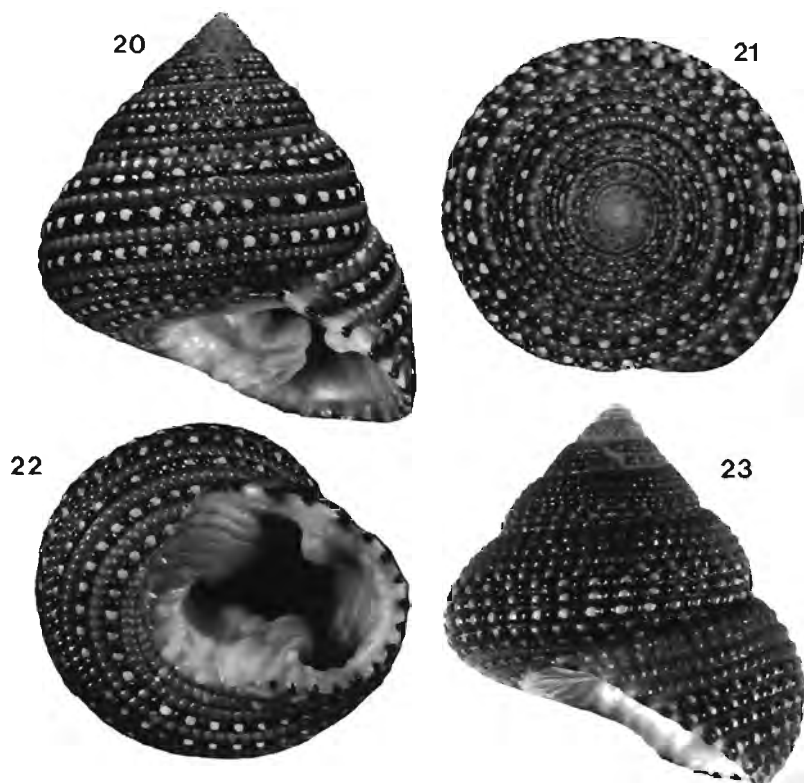
Trochus (Clanculus) flosculus; von Martens, 1880: 296.

Clanculus flosculus; Dautzenberg, 1923: 56; *idem*, 1929: 331(537); Spry, 1968: 33, N° 275; Kaicher, 1980: 2203; Herbert, 1991a: 307, figs 3–6.

Clanculus rarus; Abbott & Dance, 1982: 43; Drivas & Jay, 1988: 36, pl. 3, fig. 2.

Diagnosis: Adult colour pattern consisting of uniform orange/red-brown cords alternating with articulated black and white cords; shell relatively small and elevated, profile trochoid-turbiniform, sutures weakly indented and not channelled; periphery more or less evenly rounded; spiral cords sculptured with well-defined granules; apertural dentition well developed, basal columella tooth compound, anal tooth present; columella disjunction deep-set; umbilicus narrow, apically filled with callus.

Description: Shell trochoid-turbiniform, relatively elevated ($L/D = 0,88-1,15$); teleoconch of up to 7,5 whorls, whorls somewhat adpressed, sutures weakly indented, not channelled; spire whorls more or less evenly conoid, becoming cyrtocoid on penultimate and body whorls; last part of body whorl in mature shells descends near aperture, the outer lip joining the penultimate whorl below periphery; base somewhat flattened, umbilicate. First teleoconch whorl with three spiral cords, one at shoulder, one at periphery and one between these; peripheral cord usually partly concealed by next whorl; all three cords become patterned with deep pink to crimson spots (dashes) during second whorl; these become black-articulated cords of later whorls; intermediary spiral cords arise during third whorl, usually one between each primary cord, these become the uniformly coloured cords of subsequent whorls; body whorl usually with 6 spiral cords (occasionally more) between suture and periphery (inclusive), three articulated, three uniformly coloured (Fig. 7); subsutural cord sometimes slightly larger than others, but rarely markedly so. All spiral cords granular from an early stage; granules coarse and well-defined, subcircular to roundly quadrate. Intervals between cords well defined, narrower than width of cords themselves, sculptured by close-set, prosocline, axial pliculae and sometimes fine spiral lirae (Fig. 7). Base sculptured with ± 9 , more close-set cords, 3–4 of which are



Figs 20–23. *Clanculus flosculus* (Fischer, 1878). 20–22, neotype *Trochus flosculus* Fischer, 1878, length 12,2 mm, diameter 11,0 mm (MNHN); 23, aberrant colour pattern produced by damage to growing margin at an early age, diameter 10,0 mm (NMSA H4043).

articulated; granules on cords more quadrate, smaller and less elevated; intervals between cords narrow, sometimes retaining traces of axial pliculation. Umbilicus open, but relatively narrow, surrounded by inductural callus and apically filled-in with callus; mature apertural dentition well developed; umbilicus bordered by 4–6 ridge-like denticles; parietal tooth present and parietal ridges well developed; interior of outer lip with spirally aligned, ridge-like denticles, the uppermost of which is considerably larger and forms a well-developed, peg-like, anal tooth; edge of outer lip with elongate black denticles marking ends of external spiral cords, denticles usually disjunct from internal ridges; basal columella tooth prominent, sculptured by 2–3 ridges; columella recurved but not strongly so; columella lip usually with slight swelling or denticle above basal columella tooth; abapical upper columella denticle a rounded bulge, adapical one scarcely distinct from columella, intervening notch weak; peristome incomplete, disjunction between columella and paries very deep-set; interior nacreous when fresh, but losing iridescence with time.

Protoconch (Fig. 24): Diameter 220–240 μm , $\pm 1,25$ whorls; translucent white; superficially smooth, apex slightly beaked, terminal lip sinuous.

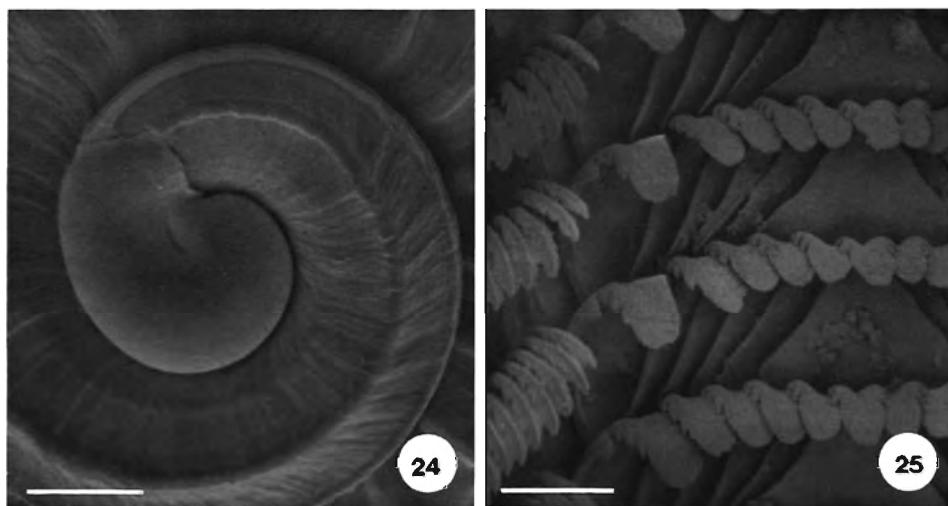
Colour: Early whorls translucent, suffused with pink and with deep pink-crimson

spots on all three spiral cords (peripheral cord sometimes not visible)(middle cord lacking spots in *atricatena* and *puniceus*); adult colour pattern develops during fourth whorl and comprises alternating articulated cords and uniform orange/red-brown cords; articulated cords comprising alternating black and white granules (occasionally paired – two black and two white); frequently two uniformly coloured cords immediately below peripheral articulated cord. Specimens with aberrant colour patterns are occasionally found (Fig. 23), but such individuals usually have a marked growth flaw at some point on the shell, prior to which the coloration is normal. Inductural callus white, somewhat translucent; interior white; outer lip with black spots.

Dimensions: Largest NMSA specimen, length 13,4 mm, diameter 13,6 mm; smallest specimen with mature apertural dentition, length 8,1 mm, diameter 8,9 mm.

Operculum: Corneous; multispiral with a central nucleus; yellowish-gold; outer face smooth and glossy.

Radula (Fig. 25): Very similar to that of *C. puniceus*; rachidian cusp narrower and more deeply indented in the mid-line.



Figs 24–25. *Clanculus flosculus* (Fischer, 1878). 24, protoconch, NMSA S2269, bar = 100 μ m; 25, portion of radula, ex NMSA E2481, bar = 50 μ m.

External anatomy: Like that of *C. puniceus*, but epipodial fold scalloped and papillation of epipodium in general more strongly developed; hoods of epipodial sense organs and free margin of both neck lobes with micropapillate digitations. Sides of foot and underside of epipodium with alternating longitudinal bands of orange-red and black or with longitudinally aligned rows of elongate black spots on an orange-red ground, similar coloration on snout; cephalic tentacles greyish-black tinged with orange-brown and with two paler longitudinal lines dorsally; epipodial tentacles greyish-black ventrally, but paler dorsally.

Distribution (Fig. 26): East Africa and western Indian Ocean islands (Aldabra, Chagos, Coetivy, Madagascar, Mauritius, Réunion, Seychelles); for more detailed regional locality data see Herbert (1991a). Locally not uncommon in coral reef systems. Living specimens have been found under rocks and coral slabs at depths of 7–22 m.

Type material: Fischer's description indicates that the original material of this species

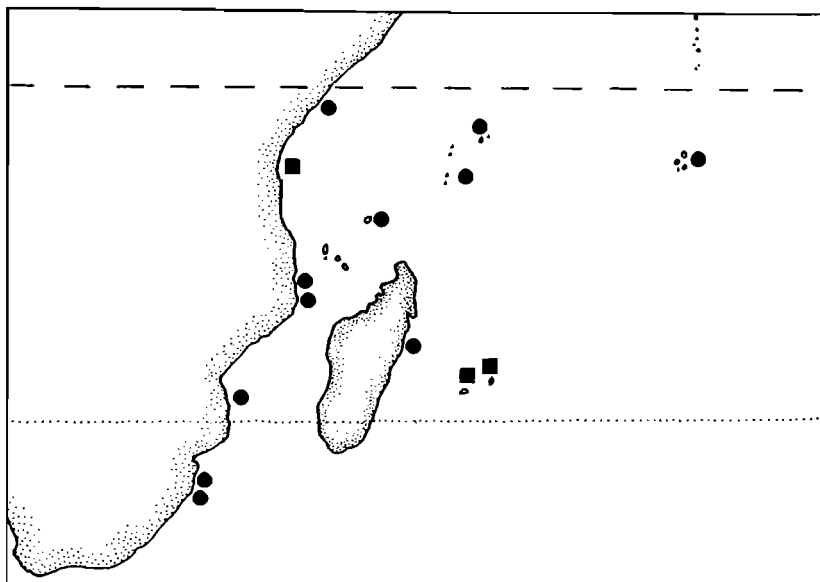


Fig. 26. Map showing distribution of *Clanculus flosculus* (Fischer, 1878); black circles = material examined, black squares = literature records.

was collected by Rousseau and was in "Mus. Parisiense" (MNHN). Unfortunately, it cannot now be traced in the MNHN collections (Métivier in lit.) and must therefore be considered lost. I take this opportunity to designate a neotype for *Trochus flosculus* Fischer, 1878 (Figs 20–22). Neotype data: Seychelles, Cerf Is. group, leg. R. C. Wood (MNHN, ex NMSA, ex Umtali Museum, Zimbabwe), dimensions length 12,2 mm, diameter 11,0 mm.

Remarks: I have previously discussed the occurrence of *C. flosculus* in southern Africa (Herbert 1991a) and gave reasons why the name *Trochus rarus* Dufo, 1840, sometimes regarded as an earlier name for the species, should be regarded a *nomen dubium*.

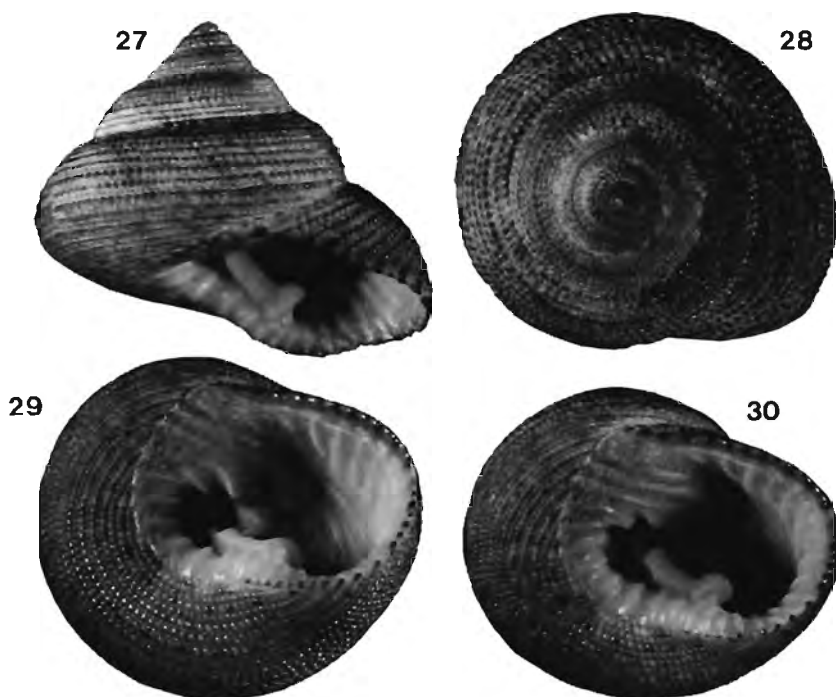
Etymology: *Flosculus*, the diminutive of *flos* (L.) m. – a flower.

***Clanculus (Clanculus) natalensis* sp. n.**

Pl. 1e, Figs 10, 27–35.

Diagnosis: Shell moderate to small (diameter <13,0 mm), light to mid orange-brown with occasional darker patches, but never with black-articulated cords; profile

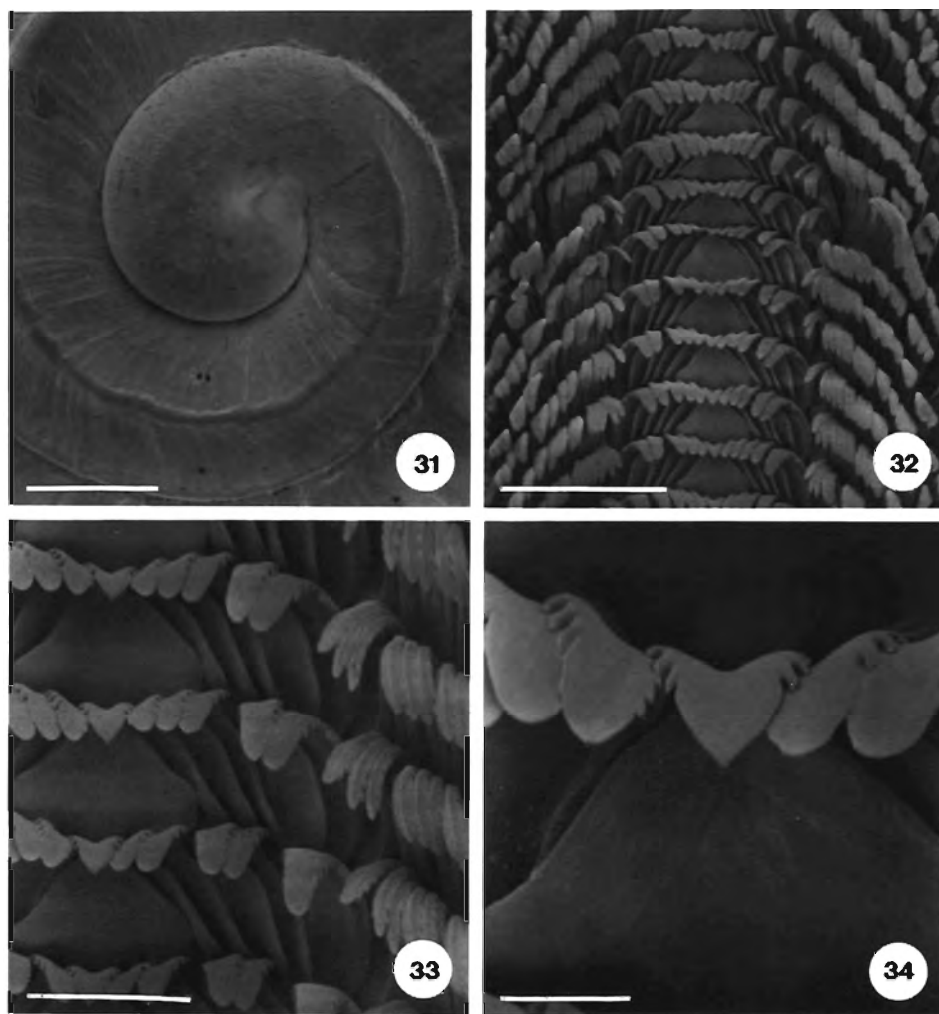
trochoid-turbiniform, sutures weakly indented and not channelled; periphery more or less evenly rounded; spiral cords relatively narrow and numerous with fine granules; basal columella tooth compound when fully mature, anal tooth absent; columella disjunction deep-set; umbilicus deep, open virtually to apex.



Figs 27–30. *Clanculus natalensis* sp. n.; holotype NMSA D6485/T889, length 10,3 mm, diameter 12,0 mm.

Description: Shell trochoid-turbiniform ($L/D = 0,85-0,91$); teleoconch of up to 6,5 whorls, whorls somewhat adpressed, sutures weakly indented, not channelled; spire whorls more or less evenly conoid, becoming cyrtoconoid on body whorl; last part of body whorl in mature shells descends near aperture, the outer lip joining the penultimate whorl below periphery; periphery more or less evenly rounded; base somewhat flattened, umbilicate. First teleoconch whorl with three spiral cords, one at shoulder, one at periphery and one between these; all three cords become coloured deep pink (in a nearly continuous line rather than isolated spots) during second whorl; intermediary spiral cords arise with growth, body whorl with up to 15 cords between suture and periphery; cords relatively narrow and finely granular from an early stage, granules subcircular (Fig. 10); primary cords originating during first teleoconch whorl sometimes slightly stronger than other cords on later whorls and whorls occasionally weakly angled at upper primary cord; subsutural cord sometimes broader than other cords, but more often not so. Intervals between cords approximately equal to the width of cords themselves, sculptured by close-set, axial

pliculae and sometimes a fine intermediary spiral lira (Fig. 10). Base sculptured with 10–15 first order cords and further intermediaries; granules on cords less elevated than on apical surface and somewhat more quadrate, particularly toward umbilicus;



Figs 31–34. *Clanculus natalensis* sp. n. 31, protoconch, NMSA C5358, bar = 100 μ m; 32–34, radula, ex NMSA S5378, bars = 200 μ m, 75 μ m and 20 μ m respectively.

intervals between cords narrow, sometimes with traces of axial pliculae. Umbilicus open, surrounded by inductural callus; mature apertural dentition well developed; umbilicus bordered by 6–8 ridge-like denticles; parietal tooth present, but relatively weak, sometimes little larger than first umbilical denticle; parietal ridges well developed in fully mature specimens, the innermost of which may have a tooth-like

bulge which also projects into the umbilicus; interior of outer lip with spirally aligned ridges, the uppermost of which is not enlarged to form an anal tooth; edge of outer lip with black or brown marked denticles at ends of external spiral cords, denticles usually disjunct from internal ridges; basal columella tooth prominent, but generally less well developed than in other *Clanculus s. s.* species; tooth sculptured by 2–3 ridges in fully mature specimens, but simple in others; columella noticeably recurved, basal to central section of reflected portion sometimes with 2–3 small denticles; columella lip concave, smooth, sometimes very slightly swollen in its mid region, but lacking any form of denticle immediately above basal columella tooth; upper columella denticles well developed and relatively close-set with a deep notch between them, adapical one generally more slender and more elevated than abapical one; disjunction between columella and paries deep-set; interior nacreous when fresh, but losing iridescence with time.

Protoconch (Fig. 31): Diameter 220–240 μm , $\pm 1,25$ whorls; translucent white; evidently smooth, weakly beaked, terminal lip sinuous.

Colour: Early whorls translucent, white to yellow, suffused with pink or orange, their spiral cords coloured deep pink to red; intensity of pink colour variable along cord, but never broken up into isolated spots; pink coloration of apical whorls gives way to adult coloration of light brown to orange-brown during third whorl; this colour for the most part more or less uniform, but subsutural area sometimes with slightly darker patches alternating with near white ones, occasional granules paler than ground colour; no black-articulated cords. Base of similar colour, frequently paler toward umbilicus; occasional specimens with traces of an orange-brown/yellowish-white articulation on some basal cords. Inductural callus white, somewhat translucent; interior white; outer lip with dark brownish-black spots.

Dimensions: Largest specimen, length 11,1 mm, diameter 12,8 mm; smallest specimen with mature apertural dentition, length 7,2 mm, diameter 8,2 mm, but some specimens with a diameter of up to 12,6 mm still not adult. Holotype, length 10,3 mm, diameter 12,0 mm.

Operculum: Multispiral with a cental nucleus; corneous; yellowish-brown; outer face smooth and glossy.

Radula (Figs 32–34): Much like that of *C. puniceus*, but rachidian base-plate/shaft more trigonal; rachidian cusp rather less broad, distinctly pointed in mid-line; laterals somewhat more elongate and less bluntly rounded.

External anatomy: Like that of *C. puniceus*, but less brightly coloured and with fewer black spots, head-foot mostly mottled orange-brown; epipodial sense organs with less well-developed hoods.

Distribution (Fig. 35): Northern Zululand south to north-eastern Transkei, 55–215 m; living specimens known from 65–130 m, usually associated with sponges. No specimens yet found in beach drift.

Type material (all dredged NMDP): **Holotype**, NMSA D6485/T889, off Dog Point, northern Zululand (27°06,5'S:32°52,9'E), 70 m, sandstone conglomerate; **paratypes 1–6**, NMSA D7489/T887, off Boteler Point, northern Zululand, 78 m, coarse sand; **paratypes 7–8**, NMSA S6639/T886, off Boteler Point, northern Zululand, living, 78 m, marine growths; **paratypes 9–14**, NMSA S7336/T885, off Lala Nek, northern Zululand,

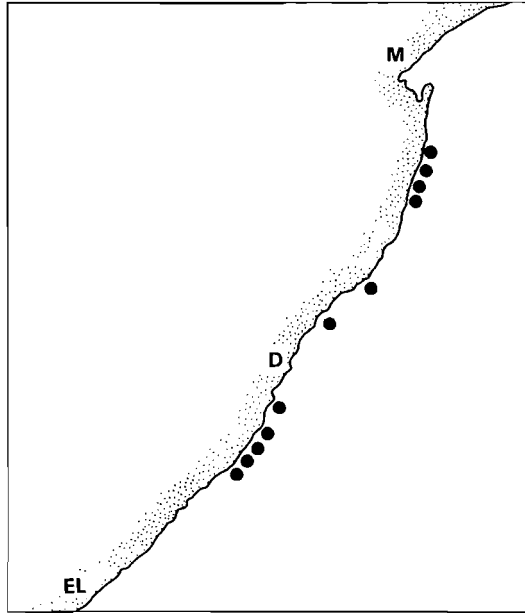


Fig. 35. Map showing distribution of *Clanculus natalensis* sp. n.; each black circle represents one or more records. M = Maputo; D = Durban; EL = East London.

72 m, slightly muddy sand, pennatulids; **paratypes 15–20**, NMSA S7435/T884, off Lala Nek, northern Zululand, 74 m, shells and sand; **paratypes 21–23**, NMSA D6756/T883, off Jesser Point, northern Zululand, living, 85 m, sponge and coral rubble; **paratypes 24–26**, NMSA E3575/T880, off Gipsy Hill, Zululand, living, 65–70 m, broken shell; **paratypes 27–29**, NMSA S5638/T856, N. E. of Gipsy Hill, Zululand, living, 63–70 m, sandstone rocks, sand and marine growths; **paratypes 30–32**, NMSA E4475/T882, off Cape Vidal, Zululand, 75–80 m, broken shell; **paratype 33**, NMSA E4906/T881, S. E. of Cape Vidal, Zululand, 110 m, sponge rubble; **paratype 34**, NMSA C1552/T879, off Park Rynie, Natal south coast, living, 101 m, some sand, sponge rubble; **paratype 35**, NMSA B7239/T878, off Park Rynie, Natal south coast, 124 m, sand; **paratype 36**, NMSA S3747/T877, off Park Rynie, Natal south coast, living, 130 m; **paratype 37**, NMSA B8887/T874, off Port Shepstone, Natal south coast, 50–55 m, sponge, bryozoans and other marine growths; **paratype 38**, NMSA C881/T873, off Mtamvuna River, Transkei, living, 75 m, rocks and sponge; **paratype 39**, NMSA S3746/T872, between Mzamba and Mpahlana Rivers, Transkei, living, 100 m, sponge rubble; **paratype 40**, NMSA C5253/T871, off Mpahlana River, Transkei, living, 100 m, sponge rubble; **paratype 41**, NMSA E211/T876, off Port Grosvenor, Transkei, 80 m, calcareous coral nodules and *Lithothamnion* sheets; **paratype 42**, NMSA E6982/T875, off Port Grosvenor, Transkei, 82 m, worn coral nodules;

Additional material (all NMSA, dredged NMDP, dead, unless indicated otherwise): ZULULAND: off Boteler Point, living, 66 m, sand, rocks (S3954); do, living, 75 m, rocks, sand and gorgonians (S5378); do, living, 78 m, marine growths (S6639); off

Dog Point, living, 74 m, sandstone rubble, gorgonians (S6472); off Rocktail Bay, living, 78 m, sandstone rocks (S4673, S6508); do, 80 m, rocks and marine growths (S5479); do, 100 m, sand (S5155); off Lala Nek, 66–71 m, coarse sand, sandstone rocks (S9012); do, 72 m, slightly muddy sand, pennatulids (S7336); do, 74 m, shells, sand (S7435); do, 74 m, sandstone rocks (S7251); do, 75 m, coarse sand, sandstone, (S3769); do, living, 75m, coarse sand, sandstone, coral (S5841); do, living, 78 m, sponges, shell (S7511); off Gobey's Point, 55–100 m, sand, shell rubble (D6646); off Sodwana Bay, 70 m, dead coral rubble (S4519); do, 77 m, dead coral rubble (S4799); off Liefeldt's Rocks, 100 m, decomposed coral rubble (E4090); off Gipsy Hill, 62–84 m, sandstone rocks, coarse sand (S5891); do, 70–80 m, sandstone rocks and coarse sand (S4615); off Leadsman Shoal, 100 m, dredged CSIR Water Research (B4047); N. E. of Leven Point, 105 m, sandstone rubble, old shells (E4835); off Cape Vidal, 75–80 m, broken shell (E7458); S. E. of Port Durnford, 95 m, sponge rubble (E8575, E8420); do, 100 m, mud and sponge rubble (E8638); do, 100 m, rocks and sponge rubble (E8352); do, glutinous sandy mud (E3114). NATAL: off Glenton Reef, coarse sand and shell (S542); S. E. of Green Point, 100 m, fine sand and rubble (D3967); between Green Point and Widenham, living, 70 m, coarse sand and sponge (D3520); off Mbizane River, living, 100 m, coarse sand, some sponge (B7234). TRANSKEI: off Mtamvuna River, 115 m, rocks and sponge (C486); between Mpahlana and Umyameni Rivers, living, 100 m, sponge rubble (C5386); off Sikombe River, north of Mtentu River, living, 112 m, sponge rubble (C5358).

Remarks: Referral of this species to *Clanculus s. s.* is somewhat tentative in view of its lack of an enlarged anal tooth; however, in other respects the apertural dentition is close to that of the nominate subgenus. It is the only southern African member of *Clanculus s. s.* which lacks black-articulated spiral cords and the only one which has not been found in beach drift.

The holotype of *C. mauritianus* Melvill, 1909, (BMNH 1910.3.17.4) dredged off Mauritius, reportedly in deep water (500–600 fathoms), is similar (see Herbert 1993), particularly in its lack of an anal tooth in the aperture, but it has three deep pink articulated cords on the adapical surface and three more on the base. Additionally its sculpture is coarser with fewer, more strongly granular, spiral cords. Drivas & Jay (1988) have identified littoral specimens from the Mascarene Islands as *C. mauritianus*, but these actually represent *C. largillierti* (Philippi, 1849) (Herbert 1993).

Etymology: *Natalensis* – from Natal.

Clanculus (Clanculus) puniceus (Philippi, 1846)

Pl. 1b, Figs 2, 8, 36–46.

Monodonta punicea Philippi, 1846: 100 N° 13. Type loc.: given as 'New Zealand', but here emended to Durban.

Trochus puniceus; Krauss, 1848: 100, N° 20; Philippi, 1849: 73, N° 71, pl. 14, fig. 2; Fischer, 1877: 167, pl. 56, fig. 1a.

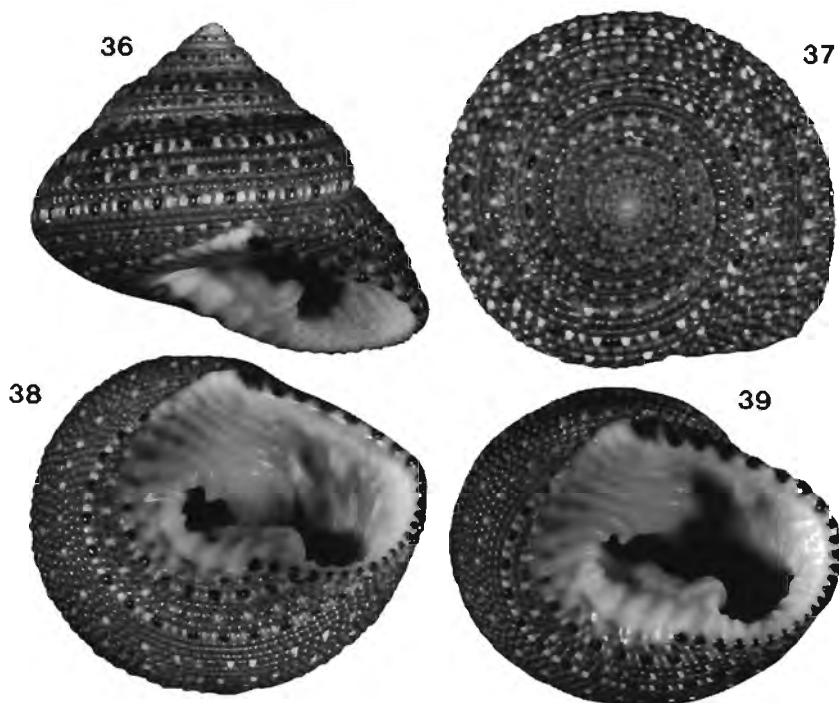
Trochus (Clanculus) puniceus; von Martens, 1879: 735; Pilsbry, 1889: 49, pl. 15, figs 59–61; Lamy, 1909: 331; Thiele, 1917: 562.

Clanculus puniceus; Sowerby, 1892: 45; Thiele, 1900: 248; Odhner, 1919: 14, 32; Dautzenberg, 1923: 56; *idem*, 1929: 537(331), Paes da Franca, 1960: 55, pl. 1, fig. 8; Barnard, 1963: 246, fig. 14a, radula; Spry, 1968: 7, pl. 6, fig. 7; Day, 1969: 160; Macnae & Kalk, 1969: 118, 127; Moura, 1972:

20, pl. 2, fig. 4; Kensley, 1973: 71, N° 73; Kaicher, 1980: 2247; Springsteen, 1981: 3, fig. 1; Kilburn & Rippey, 1982: 40, pl. 8, fig. 9; Mienis, 1982: 60; *idem*, 1990: 8; Drivas & Jay, 1988: 36, N° 1; Jouk & Revis, 1988: 38.

Clanculus miniatus (*non* Anton, 1838); Macnae & Kalk, 1969: 84, fig. 20q.

Diagnosis: Shell relatively large (adult diameter >15,0 mm), orange-red to crimson, two spiral cords on adapical surface articulated with black and near white markings; profile trochoid-turbiniform, sutures weakly indented and not channelled; periphery more or less evenly rounded; spiral cords relatively broad, on apical surface usually wider than their intervals, granules coarse; basal columella tooth compound, anal tooth present; columella disjunction not deep-set; umbilicus deep, open virtually to apex.



Figs 36–39. *Clanculus puniceus* (Philippi, 1846), four views of a typical shell from Zululand, NMSA D5734, length 16,8 mm, diameter 19,6 mm.

Description: Shell trochoid-turbiniform ($L/D = 0,75-1,05$); teleoconch of up to 7 whorls, whorls somewhat adpressed, sutures weakly indented, not channelled; spire whorls more or less evenly conoid, becoming cyrtoconoid on penultimate and body whorls; last part of body whorl in mature shells descends near aperture, the outer lip joining the penultimate whorl below periphery; base somewhat flattened, umbilicate. First teleoconch whorl with three spiral cords, one at shoulder, one at periphery and one between these; upper and lower cords become patterned with deep pink to

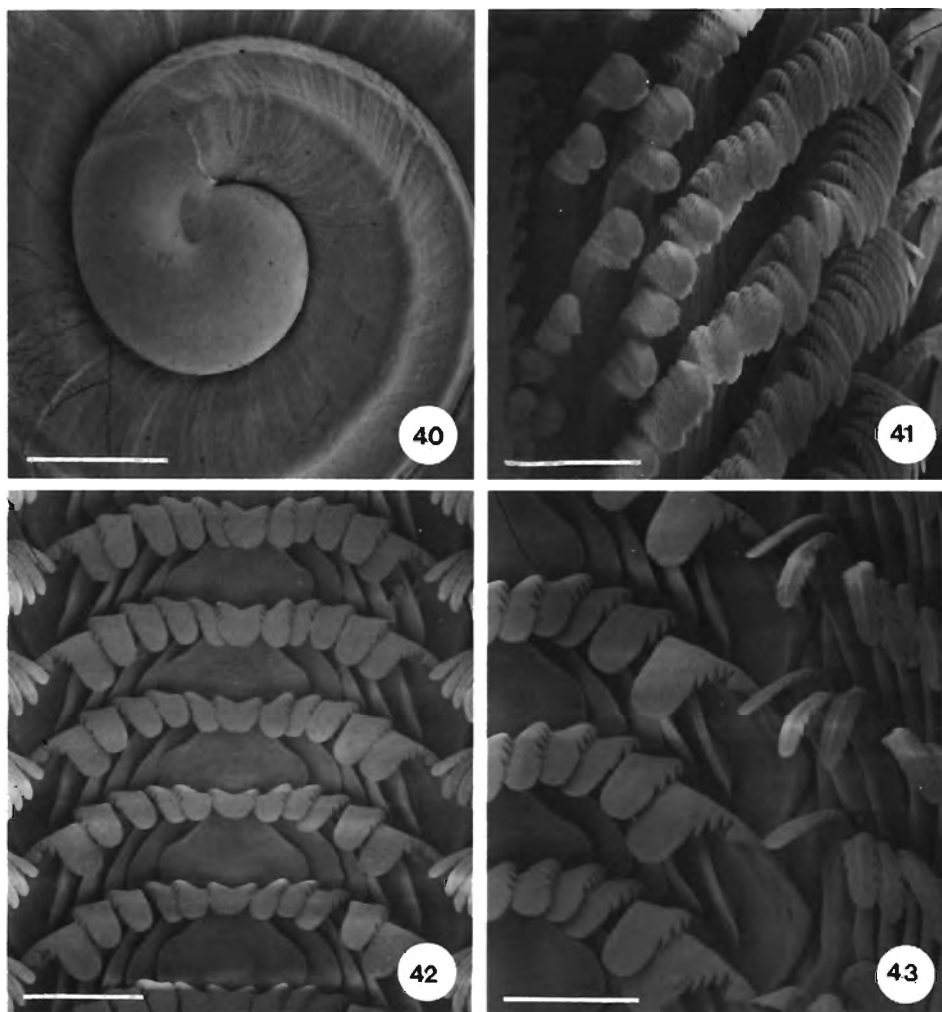
crimson spots (dashes) during second whorl; these cords become black-articulated cords of later whorls; intermediary spiral cords arise with growth, body whorl with 8–9 (usually 8) cords between suture and periphery; subsutural cord of later whorls arising during second whorl, wider than remaining cords; 2 cords between subsutural cord and upper articulated cord, 3 (occasionally 4) between upper and peripheral articulated cords. All spiral cords granular from an early stage; granules roundly quadrate, relatively coarse (Fig. 8); granules of subsutural cord usually somewhat flattened and axially elongate. Intervals between cords narrow, distinctly narrower than the width of the cords themselves, sculptured by close-set, axial pliculae and/or spiral lirae. Base sculptured with 14–17 more close-set cords; granules on cords smaller, less elevated and more obviously quadrate, particularly toward umbilicus; intervals between cords narrow and not obviously sculptured. Umbilicus open almost to apex, surrounded by inductural callus; mature apertural dentition well developed; umbilicus bordered by 5–7 ridge-like denticles; parietal tooth present, size variable, but usually prominent and sometimes compound; parietal ridges well developed; interior of outer lip with spirally aligned, ridges, the uppermost of which is considerably larger and forms a well-developed anal tooth; edge of outer lip with black labral denticles marking ends of external spiral cords, denticles usually disjunct from internal ridges; basal columella tooth prominent, sculptured by 2–3 ridges; columella recurved but not strongly so, basal section of reflected portion sometimes with 2–3 small denticles; a further slight swelling or denticle on columella lip above basal columella tooth; abapical upper columella denticle a rounded bulge, adapical one variable in size but usually smaller and sometimes scarcely evident at all, intervening notch weak; disjunction between columella and paries not deep-set/relatively shallow; interior nacreous when fresh, but losing iridescence with time.

Protoconch (Fig. 40): Diameter $\pm 240 \mu\text{m}$, $\pm 1,25$ whorls; translucent white to yellowish-white.

Colour: Early whorls translucent, suffused with pink or orangish-pink, later whorls orange-red (scarlet) to crimson; specimens from Natal (including Zululand) generally brick-red/brownish red, those from Mozambique crimson; in Natal specimens spiral cords frequently orangish-red, their intervals somewhat brighter red (slightly pinkish); spiral cords rather irregularly articulated with paler (whitish) granules; adapical and peripheral spiral cords of first teleoconch whorl become articulated with deep pink spots (dashes) during second whorl, turning black on third and subsequent whorls; spots usually covering only a single granule (Fig. 8); intervals of 2–3 pale (whitish) granules between black ones; lower black-articulated cord remaining near periphery, adapical one lying between this and suture; middle spiral cord of first and second teleoconch whorls rarely patterned initially, but on subsequent whorls frequently articulated with single whitish granules separated by 2–3 reddish ones. Base with two black-articulated cords, one close to umbilicus, the second lying peripheral to this and separated from it by 2–3 uniformly coloured reddish cords; 1–2 spiral cords, lying between outer basal and peripheral black-articulated cords, articulated with whitish granules. Inductural callus white, somewhat translucent; interior white; outer lip with black spots.

Dimensions: Largest NMSA specimen, length 20,0 mm, diameter 22,7 mm; smallest specimen with mature apertural dentition, length 11,5 mm, diameter 15,0 mm.

Operculum (Figs 44–45): Multispiral (>12 whorls), with a central nucleus; comeous and relatively thick, orange-brown to smoky-brown; outer face concave, smooth and glossy.



Figs 40–43. *Clanculus puniceus* (Philippi, 1846). 40, protoconch NMSA E267), bar = 100 μ m; 41–43, radula, ex NMSA E715: 41, marginal teeth, bar = 75 μ m; 42, central field, bar = 100 μ m; 43, latero-marginal area, bar = 75 μ m.

Radula (Figs 41–43): Long, 80–100 transverse rows; formula $\infty + 5 + 1 + 5 + \infty$; rows evenly curved, but with a slight posterior dip in the mid-line. Rachidian medially indented at junction of shaft and cusp; cusp bluntly and more or less evenly rounded, width approx. a quarter to one third that of base plate, lacking hood-like

lateral flanges, but with 3–4 small secondary cusps laterally at the base of the main cusp. Cusps of lateral teeth somewhat more elongate than that of rachidian, but likewise bluntly rounded; 3–4 secondary cusps on outer margin at base of main cusp; inner margin frequently finely serrate, but often obscured due to tooth overlap; outer margin of shaft of fifth lateral somewhat expanded, terminating distally as an additional cusp at junction of shaft and main cusp. Tooth overlap in central field extensive, but interaction between shafts and base-plates of neighbouring teeth relatively simple. Innermost marginal with base-plate expanded longitudinally, but otherwise not obviously differentiated from remaining marginals; marginal cusps elongate, denticulate on both sides and with a central thickened ridge; cups becoming less elongate and lateral denticles progressively finer and more numerous toward edge of radula.



Figs 44–45. *Clanculus puniceus* (Philippi, 1846), operculum. 44, from specimen with fully developed apertural dentition, NMSA E2522, diameter 5,1 mm; 45, from subadult specimen lacking apertural dentition, NMSA S1480, diameter 4,8 mm.

External anatomy (Fig. 2): Forehead wide with well-developed cephalic lappets, separated medially only by a narrow gap, free margin of lappets fimbriate; cephalic tentacles prominent, micropapillate; eyestalks short, fused basally to cephalic tentacle, eye subterminal, black; right post-optic tentacle evidently absent; snout broad, distally truncate and widely expanded ventro-laterally on both sides; oral disc essentially D-shaped, but flaring ventro-laterally, lips with irregularly radiating folds and split mid-ventrally; left neck lobe broadest anteriorly, tapering smoothly into epipodial fold posteriorly, anteriorly disjunct from eyestalk, margin fimbriate and beset with numerous small, micropapillate processes, upper surface with close-set, somewhat irregular, transverse folds; right neck lobe similar to left one but anteriorly fused to base of right eyestalk, dorsal surface more or less smooth and free margin more even but still microscopically digitate. Epipodial fold well developed, free edge strongly fimbriate; four (occasionally five) micropapillate epipodial tentacles on each side one immediately posterior to neck lobe, one at anterior edge of operculum and

two beneath operculum; epipodial sense organs present at base of each epipodial tentacle and one beneath each neck lobe, each sense organ raised on short stalk which expands dorsally over sense organ as a papillate hood; sense organ beneath first epipodial tentacle usually displaced somewhat posteriorly to lie between first and second tentacles (particularly so on right); epipodial fold continues posteriorly beyond operculum and joins in mid-line. Sides of foot made rugose by numerous close-set papillae; foot (in preserved specimens) truncated anteriorly, roundly tapering posteriorly; sole grooved longitudinally in mid-line with numerous transverse folds; dorsal portion of foot posterior to operculum flattened and bearing a longitudinal glandular slit in mid-line.

Animal for the most part yellowish-white, but coloration of head and foot similar to that of shell viz:- bright orange-red to crimson with black spots; sole of foot yellowish-white; cephalic and epipodial tentacles orange brown, without black transverse rings. Colours faded in preserved material.

Ctenidium bipectinate almost throughout (only posterior $\frac{1}{8}$ monopectinate), afferent ctenidial membrane long, extending well beyond junction of transverse pallial vessel, anterior $\frac{1}{4}$ – $\frac{1}{8}$ of ctenidium free.

Distribution (Fig. 46): East Africa from Ras Asir (Cape Guardafui) south to southern Natal; Madagascar and the Mascarene Islands and possibly also the Red Sea (Mienis 1990). I know of no records from the Persian Gulf or Arabian Sea. The shell from

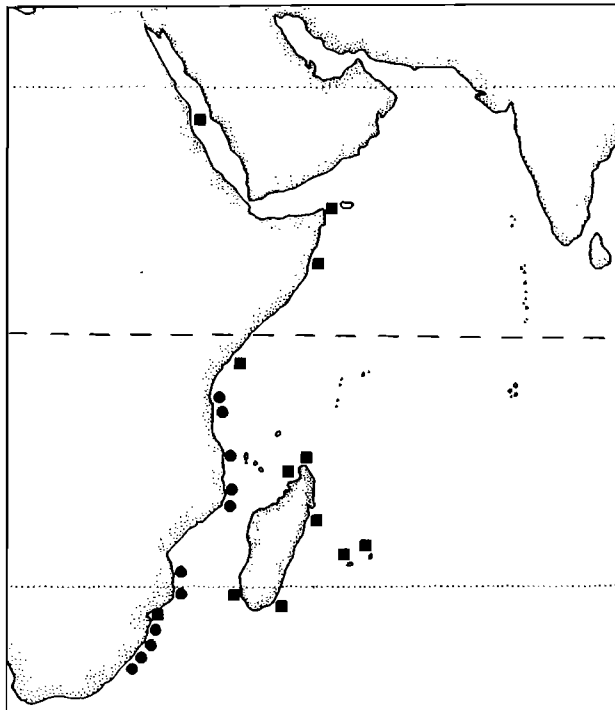


Fig. 46. Map showing distribution of *Clanculus puniceus* (Philippi, 1846); black circles = material examined, black squares = literature records.

Oman figured by Bosch & Bosch (1982) as *C. puniceus* is in fact *C. pharaonius* (Linnaeus, 1758).

C. puniceus is a common East African species occurring predominantly in coral reef environments, both intertidally and subtidally. It is most often found under rocks and dead coral blocks. In Zululand, intertidal habitats are not of this nature, but the species remains common on subtidal reefs, where living specimens have been found at depths down to 22 m. It is much less frequently encountered towards the southern end of its distribution on the Natal south coast.

Selected locality data (all NMSA): TANZANIA: Dar-es-Salaam, Makatumbi Island group, R. C. Wood, *ex* Umtali Mus. (J7953); Mafia Island (Chole Island), below loose rocks on dead coral-rock reef flats, R. C. Wood, *ex* Umtali Mus. (J7952). NORTHERN MOZAMBIQUE: Quirimba Island, under rocks and dead coral, RK (J9113); Nacala Bay, K. Grosch (H3969); Conducia Bay, K. Grosch (many samples). SOUTHERN MOZAMBIQUE: Bazaruto Archipelago, E. Roscoe (G92, G1911, J9594, J9607); do, between Bazaruto Is. and mainland, dredged living 3–15 m, R. Cruickshank (K7414); Inhambane, R. Cruickshank (F6999). ZULULAND: Kosi Bay, main coral reef 1–4 km south of estuary mouth, depths between 9 and 22 m, living specimens 16–22 m, dived DH *et al.* (D9243, S1016, S1405); between Bhanga Neck and Kosi Bay, living, 5–20 m, dived DH *et al.* (D9429, D9509, S1480, S1672, S2485, S2855, S3109); Boteler Point, intertidal rocks, DH *et al.* (S1573); Black Rock, exposed intertidal outcrop, DH *et al.* (S838); Sodwana Bay, coral and sponge reefs, depths between 6 and 22 m, living specimens 6–18 m, dived DH (D1816, D3219, D3308, D3318, D4940, D4966, D5112, D5213, E715, S3351); Jesser Point, intertidal reef, RK & DH (D5734); Leadsman Shoal, depths between 8 and 28 m, living specimens 9–14 m, dived DH (E2413, E2522, E2671, E2719); Leven Point, beach drift, RK & DH (D5503); Mission Rocks/Perrier Rocks, littoral, RK & DH (D5580); Cape Vidal, intertidal rocks, living, RK & DH (D5679); Mapelane, littoral, living, RK, DH & R. Fregona (D5588). NATAL: Thompson's Bay, Umhlali, intertidal swimming pool, R. & J. Kilburn (B4993); Umhloti Beach (B1107); Durban, W. Falcon, H. Burnup (6356, 1209); Reunion Rocks, intertidal rocks, living, RK, DH & R. Fregona (D365, S3695); do, J. Marais (S3764); Isipingo, living, RK (8048); Isipingo Beach, J. Marais (S3753); Aliwal Shoal off Scottburgh, 10–15 m, dived DH (D782); do, 8–12 m, dived DH (S5842); Kelso (9037); Port Shepstone, H. Burnup (6353); Shelly Beach, Izotsha, W. G. Rump (6357).

Type material: The location of Philippi's original material of this species is unknown. None is present in the ZMHB (personal observation) and, if there is any still extant, the most probable repository would be the National Museum of Natural History in Santiago, Chile.

Type locality: The original type locality, given as '? New Zealand' is obviously erroneous. Krauss (1848) was the first author to provide correct locality data for this species and it is even possible that the original material was collected by him during his visit to the Durban area during 1839–40. I here emend the type locality to Durban.

Remarks: There has been confusion in the literature and in museum collections between this species and *C. pharaonius*. In *C. puniceus* (judging from more than 200 specimens in the Natal Museum) there are always only two spiral cords with black

markings on the adapical surface, one at the periphery and one between this and the suture, each separated by 3–5 more or less uniformly coloured cords (Fig. 8). In *C. pharaonius*, however, there are two black marked cords between the periphery and the suture, with a third at or just below the periphery, separated only by 1–2 unmarked cords (Pl. 1a, Fig. 9). Furthermore, in *C. puniceus* there are usually two or three paler granules between the black markings on the spiral cords, whilst in *C. pharaonius* the granules usually alternate in colour, one black, one white, only occasionally are there two white granules between the black ones.

Etymology: *Puniceus*, *a, um*, (L.) – of a red colour, scarlet.

Subgenus *Clanculopsis* Monterosato, 1879

Clanculopsis Monterosato 1879: 222. Type species (s.d. Sacco, 1896), *Trochus cruciatus* Linnaeus, 1758. *Clanculella* Sacco, 1896: 22. Type species (monotypy) *Monodonta jussieui* Payraudeau, 1826 (Marshall, pers. com.).

Diagnosis: Basal columella tooth simple (ie. with at most one raised ridge); uppermost ridge on interior of outer lip not significantly larger than other labral ridges and not produced to form an anal tooth; apertural dentition less well developed than that of *Clanculus s. s.* and parietal ridges rarely prominent; inner portion of umbilicus filled with callus deposit. Rachidian tooth of radula with cusp half or more than half width of shaft/base-plate (SEM confirmation required for type species).

Remarks: The following three species are tentatively placed in *Clanculopsis* on the basis of similarities in shell morphology and radula form. However, their affinities with respect to the numerous subgenera proposed for Australian species needs to be further investigated.

Clanculus (Clanculopsis) miniatus (Anton, 1838)

Pl. 1f, Figs 3, 11, 47–65.

Trochus miniatus Anton, 1838: 58, N° 2079; Philippi, 1843: 33, *Trochus* pl. 1, fig. 7; *idem*, 1849: 99, N° 108, pl. 16, fig. 10; Krauss, 1848: 99; von Martens, 1874: 17; Fischer, 1878: 242, N° 129, pl. 83, fig. 1; Pilsbry, 1889: 58, pl. 10, figs 23, 24. Type loc.: not given, but here designated to be off Simonstown, False Bay.

Clanculus carinatus A. Adams, 1853: 162, N° 42; Sowerby, 1892: 45. Type loc.: originally unknown, but “S. Africa” subsequently added to original board, and Port Elizabeth given by Sowerby, 1892.

Trochus (Clanculus) depressus (non Philippi, 1849); von Martens, 1874: 17; Smith, 1903: 389, N° 288.

Trochus miniatus var. *carinatus*; Pilsbry, 1889: 58, pl. 14, figs 24, 25.

Clanculus laceyi Sowerby, 1889a: 11, pl. 1, fig. 16; *idem*, 1892: 45, pl. 2, fig. 44; Barnard, 1963: 249.

Type loc.: Port Elizabeth. **Syn. n.**

Trochus (Clanculus) laceyi; Pilsbry, 1889: 82, pl. 18, fig. 21.

Gibbula miniata; Sowerby, 1892: 44.

Clanculus miniatus; Smith, 1903: 388; Bartsch, 1915: 150; Turton, 1932: 178, N° 1258 [but not pl. 42 N° 1258 = a juvenile *Clanculus waltonae* Sowerby, 1892]; Barnard, 1963: 248, figs 15a, b; Day, 1969: 160; Kensley, 1973: 38, N° 71; Kaicher, 1980: N° 2237 syntype of *C. carinatus* Adams, 1853; Springsteen, 1981: 3, fig 2; Kilburn & Rippey, 1982: 40, pl. 8, fig. 7.

Clanculus alfredensis Bartsch, 1915: 150, pl. 23, figs 10–12; Turton, 1932: 180, N° 1264. Type loc.: Port Alfred.

Clanculus miniatus carinatus; Turton, 1932: 179, N° 1259.

Clanculus elevatus Turton, 1932: 179, N° 1260, pl. 42. Type loc.: Port Alfred.

Clanculus trochiformis Turton, 1932: 179, N° 1261, pl. 43. Type loc.: Port Alfred.

Clanculus becki Turton, 1932: 179, N° 1262, pl. 43. Type loc.: Port Alfred.

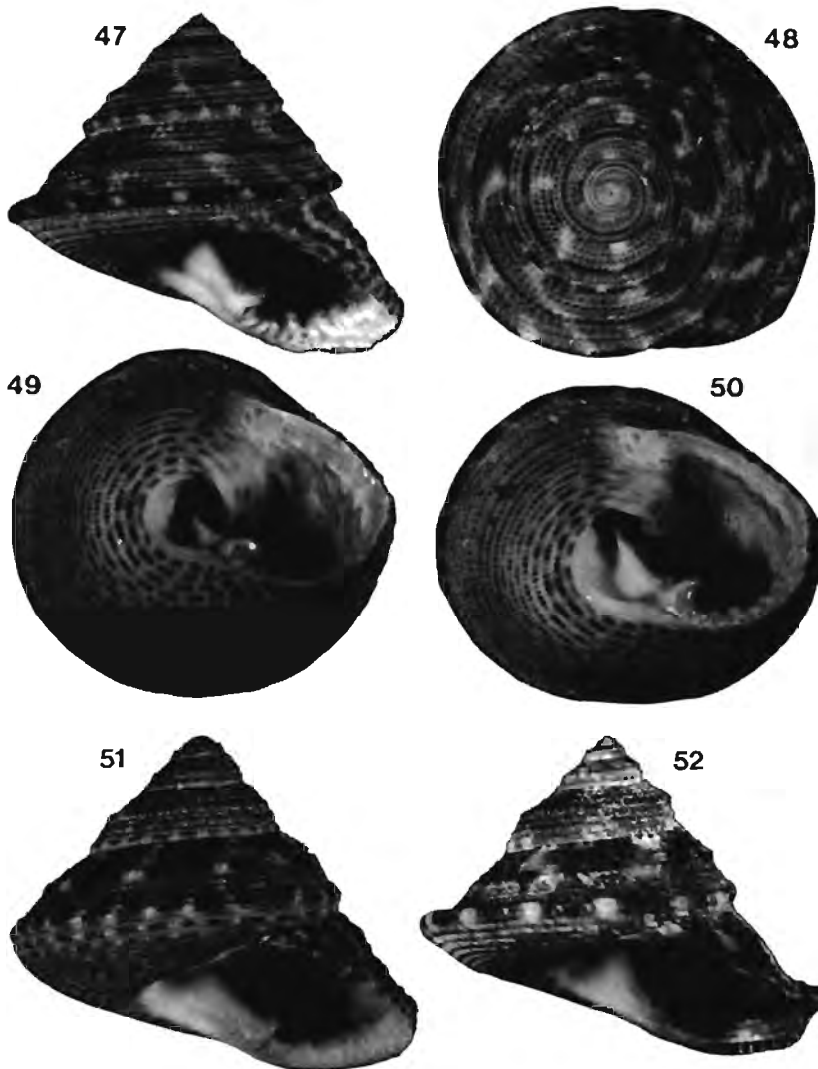
Clanculus eucosmia Turton, 1932: 179, N° 1263, pl. 43. Type loc.: Port Alfred.

Clanculus kowiensis Turton, 1932: 180, N° 1267, pl. 43. Type loc.: Port Alfred.

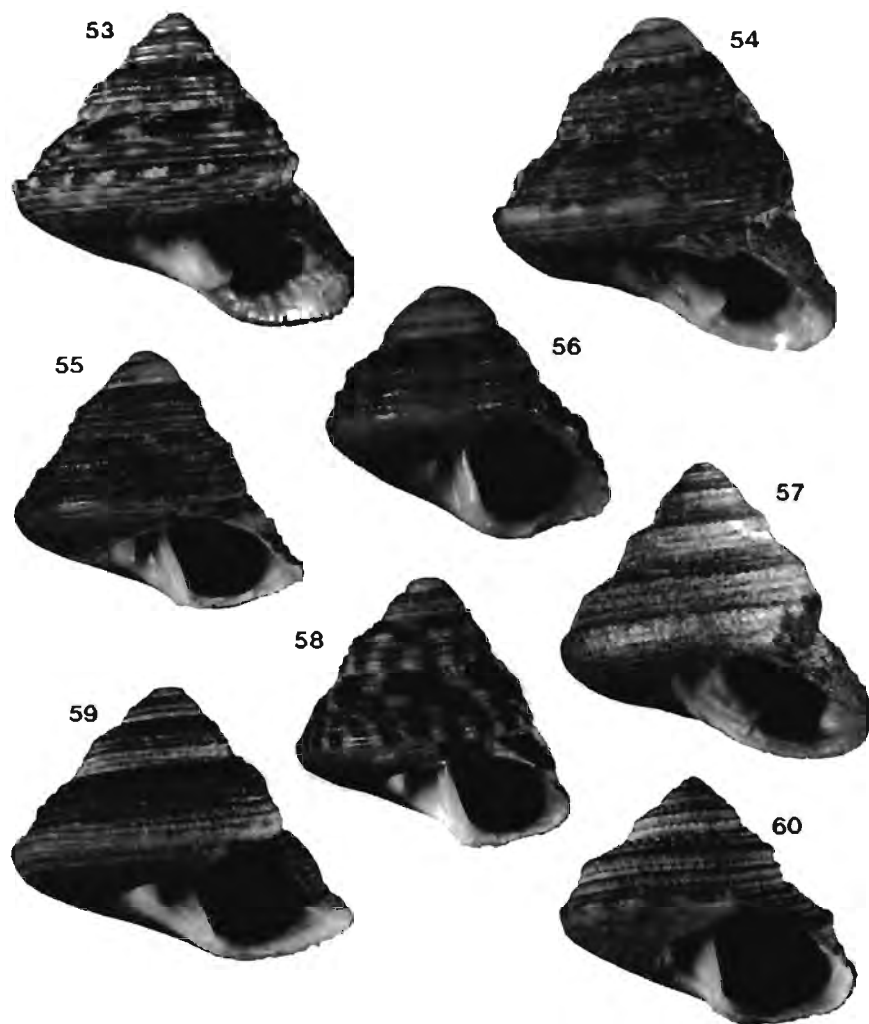
non *Clanculus miniatus*; Macnae & Kalk, 1969: 84 [= *C. puniceus* (Philippi, 1846)].

Diagnosis: Shell moderate to large, trochiform; periphery angular and frequently keeled; one spiral cord midway between periphery and suture stronger than others; basal columella tooth simple and umbilicus lacking marginal denticles; colour pattern usually of axial flames, no regular articulated markings on spiral cords.

Description: Shell trochiform, ($L/D = 0,75-1,0$); teleoconch of up to 6,5 whorls, whorls adpressed, sutures at most slightly indented, periphery below mid-whorl, angular, strongly keeled in some specimens (Fig. 52); spire profile gently



Figs 47–52. *Clanculus miniatus* (Anton, 1838). 47–50, neotype *Trochus miniatus* Anton, 1838, Simonstown dredgings, False Bay NMSA S9315/T889, length 15,0 mm, diameter 17,3 mm; 51, peripherally rounded specimen NMSA B422, diameter 14,5 mm; 52, peripherally keeled specimen, NMSA E6403, diameter 13,2 mm.



Figs 53–60. Junior synonyms of *Clanculus miniatus* (Anton, 1838). 53, lectotype *Clanculus carinatus* A. Adams, 1853, diameter 16,9 mm; 54, lectotype *Clanculus trochiformis* Turton, 1932, diameter 11,0 mm; 55, lectotype *Clanculus elevatus* Turton, 1932, diameter 10,5 mm; 56, holotype *Clanculus kowiensis* Turton, 1932, diameter 5,1 mm; 57, holotype *Clanculus laceyi* Sowerby, 1889, diameter 13,1 mm; 58, holotype *Clanculus becki* Turton, 1932, diameter 10,9 mm; 59, holotype *Clanculus eucosmia* Turton, 1932, diameter 12,3 mm; 60, holotype *Clanculus alfredensis* Bartsch, 1915, diameter 8,3 mm.

cyrtocoid; suture at periphery on early whorls, but that between body whorl and penultimate whorl frequently below periphery, particularly if periphery keeled; suture usually descending further just before aperture; base somewhat flattened, umbilicate. First teleoconch whorl with three spiral cords, one at shoulder, one at periphery and one between these; a fourth, weaker cord appearing towards end of whorl, between shoulder and adapical suture; further intermediaries arise during second and subsequent whorls; cords become coloured with deep pink during second whorl,

sometimes in discrete spots, sometimes uniformly pink; shoulder and peripheral cords usually remaining stronger than other spiral cords throughout growth; shoulder angulation frequently less obvious on later whorls and whorls often flat-sided, the shoulder cord, which usually remains stronger despite loss of whorl curvature, lying approximately mid-way between periphery and adapical suture; body whorl with 3–6 spiral cords between adapical suture and shoulder cord, a similar number between shoulder cord and peripheral cord/keel; peripheral cord frequently double or shallowly bifid; whorl profile concave immediately above and below periphery in strongly keeled specimens. Spiral cords granular from an early stage; granules round to roundly oblong, relatively fine and widely spaced, intervals between granules often as wide or wider than the granules themselves; orientation of granules variable – opisthocline, orthocline or prosocline and subject to considerable inter- and intra-individual variation, but orientation of granules on a given spiral cord usually constant; subsutural cord sometimes slightly broader than cords immediately below it. Intervals between cords relatively wide (more or less the same width as the cords), sculptured by close-set, prosocline, axial pliculae and occasional spiral lirae (Fig. 11); pliculae lamellate in fresh specimens. Base sculptured with 10–20 finer, granular cords; intervals between cords with close-set prosocline axial pliculae; outer lip below peripheral angulation usually thickened and flaring out somewhat. Umbilicus open, but upper part filled with callus deposit; umbilical margin angular and with a thickened rim, but not surrounded by inductural callus and lacking denticles; apertural dentition even in large specimens usually relatively weak; umbilical denticles and parietal tooth lacking; parietal ridges weak and present only in the most mature specimens; ridge-like denticles on interior of outer lip usually weak and frequently absent, when present they appear first and most strongly on basal portion of lip, and occur on adapical region only in the most mature specimens; enlarged anal tooth lacking; basal columella tooth present, simple, sometimes with a single raised central ridge; columella reflected, central section straight or shallowly concave and lacking additional denticles; abapical upper columella denticle a rounded bulge projecting into the aperture, adapical one slender and sometimes hardly separable from edge of reflected columella; intervening notch at most shallow; disjunction between columella and paries moderately deep-set; interior nacreous when fresh.

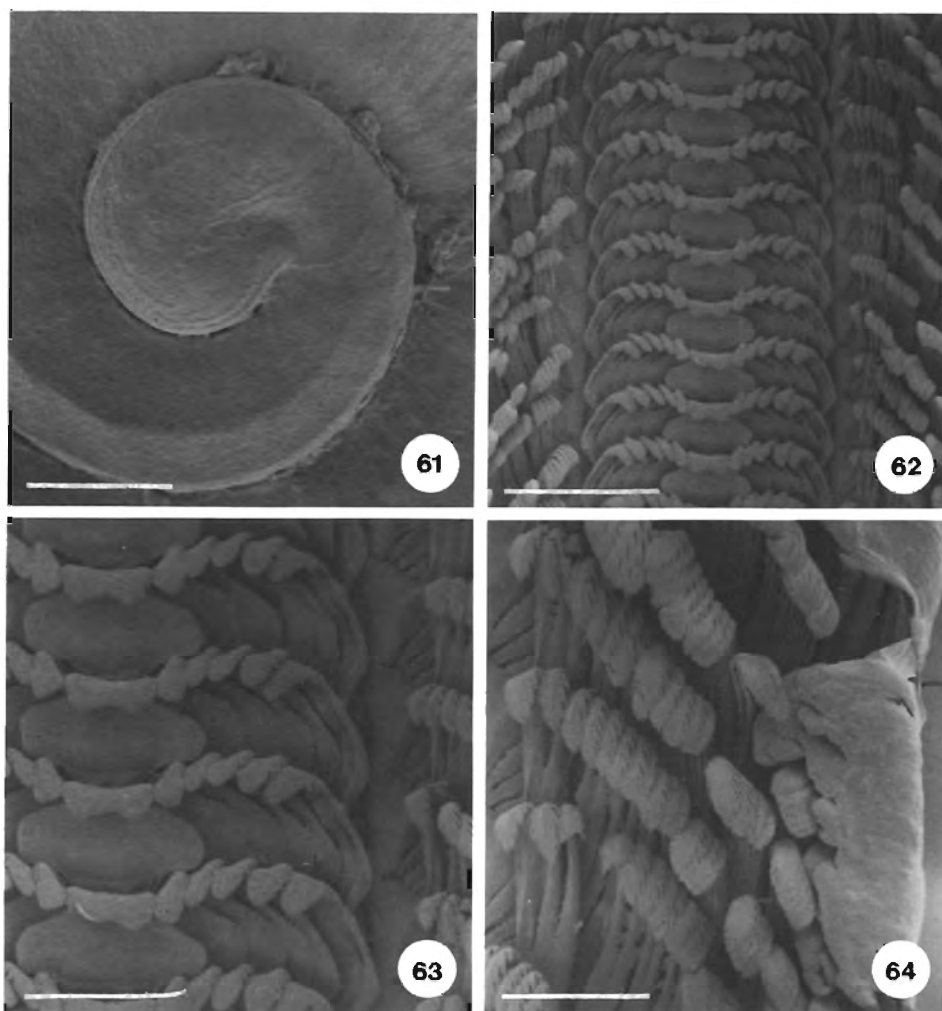
Protoconch (Fig. 61): Diameter 200–240 μm ; translucent white to yellowish-white; apical beak present; terminal lip sinuous, not thickened and with no subterminal varix; badly worn or missing in most specimens.

Colour: Apical whorls translucent, white sometimes suffused with pink; spiral cords of second and third whorls with spots or dashes of deep pink to strong red or uniformly pink to strong red. Adult colour pattern beginning during fourth whorl; ground colour white to yellowish-white or pinkish-white; most common colour pattern consisting of axial flames of light reddish-brown, dark red or dark reddish-brown; width and orientation of flames variable, but frequently broad, leaving only narrow zig-zag strips of ground colour between them; flames frequently darker subsuturally; base usually more uniformly coloured or with numerous short dashes of colour on spiral cords; hues similar to those on adapical surface. Umbilicus near white; interior nacreous; outer lip lacking black spots.

Dimensions: Largest NMSA specimen, length 14,8 mm, diameter 18,8 mm;

smallest specimen with mature apertural dentition, length, 12,3 mm, diameter 12,3 mm. Dimensions of neotype, length 15,0 mm, diameter 17,3 mm.

Operculum: Corneous; multispiral with a central nucleus; orange-brown; frequently in rather poor condition and outer surface encrusted with lustreless deposit; growing margin narrow.



Figs 61–64. *Clanculus miniatius* (Anton, 1838). 61, protoconch, NMSA S873, bar = 100 μ m; 62–64, radula, ex NMSA E6403, bars = 150 μ m, 75 μ m and 50 μ m respectively.

Radula (Figs 62–64): 60–80 transverse rows; formula $\infty + 5 + 1 + 5 + \infty$; rows evenly curved, but with a distinct posterior dip in the mid-line. Rachidian cusp broad, basal width of cusp approximately half width of widest part of shaft/base-plate; cutting

edge more or less straight or medially indented, frequently uneven; lateral margins of cusp oblique, usually with a number of small secondary cusps. Lateral teeth similar to each other in size and shape, but fifth one with outer margin somewhat expanded and thickened; cusps apically rounded with 4–6 small secondary cusps on outer margin at base, inner margin finely serrate. Tooth overlap in central field extensive but basal interaction of teeth evidently simple. Marginals numerous, cusps less elongate than in *Clanculus s. s.*; lateral denticulation of cusps progressively finer toward edge of radula; a distinct but narrow food groove lies hidden under shaft-cusp angle. Basal portion of shaft of innermost marginal expanded to form a longitudinally aligned, triangular, latero-marginal plate; cusp remaining well developed.

External anatomy (Fig. 3): Similar to that of *C. puniceus*; body generally less strongly papillate, but epipodial sense organs with well-developed papillate hoods, particularly those under neck lobes; right post-optic tentacle present. Body colour yellowish-white mottled with black on sides of foot, head and snout; tentacles white. Ctenidium bipectinate; afferent membrane extending well beyond junction of transverse pallial vein.

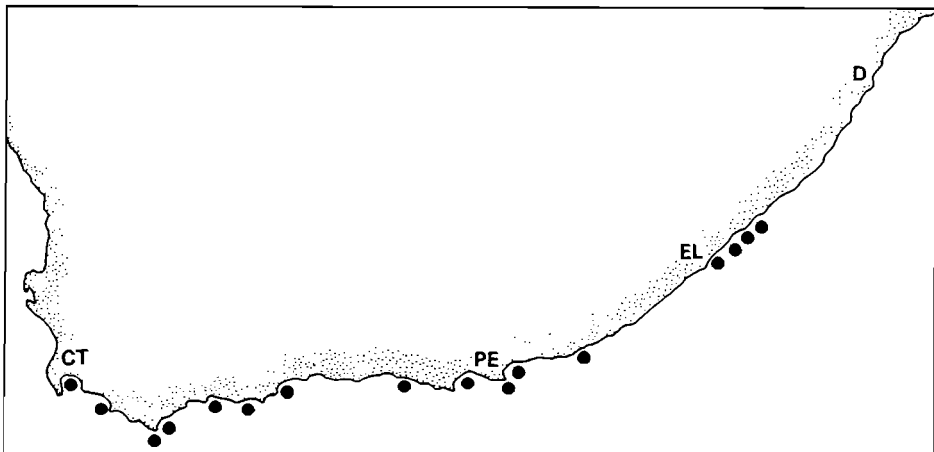


Fig. 65. Map showing the distribution of *Clanculus miniatus* (Anton, 1838); each black circle represents one or more records. CT = Cape Town; D = Durban; EL = East London; PE = Port Elizabeth.

Distribution (Fig. 65): Cape; False Bay to south-western Transkei; shallow subtidal to 38 m (living specimens the same), rocky substrata. In False Bay specimens have been found alive in sheltered pools near low tide (Kilburn & Rippey 1982). Barnard (1963) correctly rejected Krauss' (1848) record of the species from Table Bay. No specimens are known from the Atlantic Cape. The record of the species from Inhaca Island, Mozambique (Macnae & Kalk 1969) represents a misidentified *C. puniceus*.

Locality data (all NMSA, dead, unless indicated otherwise): TRANSKEI: Dwesa, beach drift, RK (C5959); Sandy Point, RK *et al.* (C3729); Qolora River mouth, RK *et al.* (C3411); Kei River, east of mouth, RK *et al.* (C3462);. EASTERN CAPE:

Haga Haga, RK (7325); off Gonubie Point, living, 38 m, sponges soft corals, gorgonians, dredged NMDP (S3772); Gonubie, C. Connolly (A3267); East London, G. Rattray, (B5578); Kayser's Beach, beach drift (S5285); Port Alfred, O. Armstrong, H. Burnup, J. Hutt, E. K. Jordan (B7347, A4559, D2495, B424, 1211); Algoa Bay, C. Alexander (A876, B1108, B5573); do, St Croix Island, 15–20 m, dived A. Connell, (A6766); do, Philip's Reef, 11 m, dived R. Emanuel (S873); do, living, ± 10 m, dived B. Hayes (D1639); Cape Recife, (B5579); Jeffrey's Bay, F. Graham, RK (B5576, B5584, 9021); do, E. K. Jordan (B422, B423). SOUTHERN CAPE: Storms River mouth, beach drift, M. Quickelberge (D2019); Mossel Bay, E. Mullens (3430); Stilbaai, C. Connolly (A3269); Witsand, St Sebastian Bay, J. Londt, L. Schoeman & B. Stuckenberg (B6797); Struis Bay, Cape Agulhas, E. Roscoe (E6601); Cape Agulhas, C. Connolly (A3265, A3266, A5450); off Hawston, near Hermanus, rocky subtidal reef ± 23 m, living, dived DH (E6403). FALSE BAY: False Bay unlocalised, living, C. Connolly (S4939); Gordon's Bay, dredged 15–17 m, hard bottom, Th. Mortensen (ZMUC); off Macassar Beach, dredged ± 20 m, C. Connolly (A3128); do, living, 25 m, rock and fragmented bryozoans, dredged NMDP (S7884); do, living, 30 m, coarse sand, rock, dredged NMDP (S8095); St James, living, C. Connolly (S5414); Fish Hoek, C. Connolly (5710, A3268); Simonstown dredgings, C. Connolly (6762, A3588); Miller's Point, C. Connolly, (A1584 living, A5536, A3057); off Castle Rocks, in subtidal kelp forest, rich soft-coral life, 5–12 m, dived DH (E6383).

Type material: Anton's type material is evidently lost and I here designate a representative specimen as neotype of *Trochus miniatus* (Figs 47–50). Neotype data, Simonstown dredgings, False Bay, leg. C. M. Connolly (NMSA S9315/T889).

The BMNH has three syntypes of *Clanculus carinatus* A. Adams, 1853 (reg. no. 196833). One is here figured and designated lectotype (Fig. 53). The holotype of *Clanculus laceyi* Sowerby, 1889, (Fig. 57) is in the Bairstow collection, OUM. The specimen approximates the dimensions given by Sowerby, but the original figure is so poor that it is impossible to be sure that this is actually the specimen represented. It is over-grown by a yellowish-brown encrustation, probably an anthomedusan hydroid.

The holotype of *Clanculus alfredensis* Bartsch, 1915, is in the USNM (186871a); it is here refigured (Fig. 60). The holotypes of Turton's *C. becki* and *C. eucosmia* are in the OUM (Figs 58 and 59 respectively). Two syntypes of *C. trochiformis* are extant, one in the OUM and the other in the NMSA (B7437/T2872); the OUM specimen was that figured by Turton and is here designated lectotype (Fig. 54). Turton's original figure was considerably retouched to obliterate defects and worm tubes. The NMSA type (now paralectotype) was originally sent by Turton to Hewitt at the Albany Museum, Grahamstown, in December 1930, prior to the publication of the species description. It was transferred to the NMSA, together with the rest of the Albany Museum Mollusca collection, in 1980.

The OUM has three syntypes of *C. elevatus* Turton, 1932, the largest of which, the figured specimen, is here designated lectotype (Fig. 55). The type lot of *C. kowiensis* Turton, 1932, also in the OUM, contains two specimens, one the holotype and figured specimen (Fig. 56), the other a juvenile specimen of *C. waltonae*. Turton

distinguished the latter from the figured specimen in his “characteristics” and I consider it to have no type status.

Type locality: I here designate the type locality of *C. miniatus* to be False Bay, an area where the species is common and where the neotype originated.

Remarks: *Clanculus miniatus* shows considerable variation in terms of shell colour, shape and sculpture and this, combined with its frequent occurrence in beach drift, is no doubt responsible for the relatively long synonymy. *Clanculus alfredensis* Bartsch, 1915, is simply a strongly sculptured juvenile of *miniatus*. The spiral keel at the adapical whorl angulation is more well developed than is perhaps normal and the axial pliculae in the cord intervals are strong, but otherwise it is typical.

Clanculus carinatus A. Adams, 1853, *C. elevatus* Turton, 1932, and *C. trochiformis* Turton, 1932, are without doubt also synonyms of *C. miniatus*. *C. eucosmia* Turton, 1932, is a keeled *miniatus* with a more uniform purplish-red colour pattern, and a pale orange-pink periphery and base. *C. becki* Turton, 1932, is simply a *miniatus* patterned with bold axial flames, and *C. kowiensis* Turton, 1932, is a rather worn juvenile *miniatus*. Barnard (1963) suspected that *C. laceyi* Sowerby, 1889, might be another synonym and I can confirm that this is true.

Though variable, *C. miniatus* is easily distinguished from other Recent southern African *Clanculus* (*Clanculopsis*) species by its size, conical profile and angular/keeled periphery. The only similar taxon is *C. murrayi* Carrington & Kensley, 1969, a Late Pliocene/Early Pleistocene fossil described from raised beach deposits on the Namaqualand coast. Carrington & Kensley stated that their taxon differed from *C. miniatus* in being more depressed and in having a double keel at the periphery of the body whorl (Carrington & Kensley 1969), but there is also a somewhat heavier deposition of callus in the parietal region and around the umbilical rim in *C. murrayi*. These differences are none the less small and it is quite possible that *C. murrayi* represents no more than an extinct subspecies of *C. miniatus* or even its ancestral form.

Relatively few specimens of *C. miniatus* seem to attain full development of the apertural dentition, a large proportion possessing only a weak basal columella tooth and little or no ridging inside the outer lip. During life the shell usually becomes encrusted, sometimes entirely so, with marine organisms such as anthomedusan hydroids, spirorbid polychaetes, cirripedes and bryozoans.

Etymology: *Miniatus*, a, um, (L.) – of the colour of cinnabar.

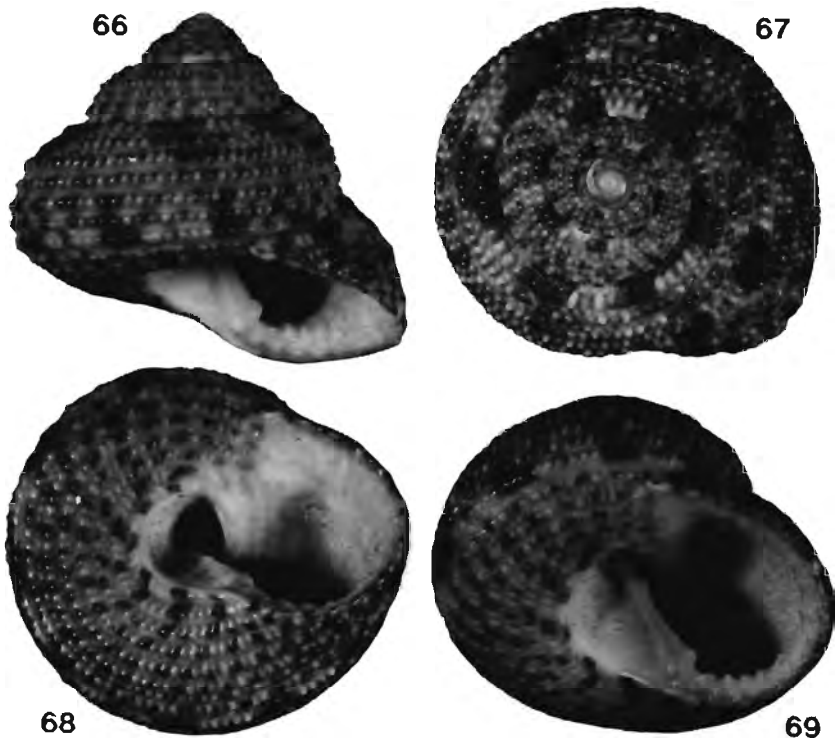
Clanculus (Clanculopsis) mixtus Smith, 1903

Pl. 1h, Figs 12, 66–71.

Clanculus mixtus Smith, 1903: 389, pl. 15, fig. 7; Turton, 1932: 180, N° 1266; Barnard, 1963: 249; Kensley, 1973: 38, N° 72; Springsteen, 1981: 3, fig. 3; Kilburn & Rippey, 1982: 40, pl. 8, fig. 8.
Type loc.: Port Elizabeth.

Diagnosis: Shell moderate to small, trochoid-turbiniform; sutures impressed and somewhat channelled; periphery more or less rounded; granules on spiral cords gemmate, subcircular to roundly rectangular, orthocline or opisthocline, not continuous with interval pliculae; interval pliculae numerous, evenly and closely spaced, never lamellate; basal columella tooth small and simple; umbilical margin

with small but distinct denticles; shell generally mottled in shades of brown or pinkish-brown on a pale ground.



Figs 66–69. *Clanculus mixtus* Smith, 1903, lectotype, length 10,9 mm, diameter 12,2 mm.

Description: Shell trochoid-turbiniform, ($L/D = 0,80-0,93$); teleoconch of up to 5,75 whorls; whorls somewhat adpressed, suture impressed, but not markedly so, sometimes rendered canaliculate by uppermost spiral cord; spire whorls more or less evenly conoid, body whorl dropping away and descending below periphery at outer lip; periphery below mid-whorl; base somewhat flattened, umbilicate. First teleoconch whorl with four spiral cords, the lowest of which is at periphery and level with suture; cords become distinctly granular during third whorl and remain so thereafter; intermediary cords arise with growth, body whorl with ± 8 cords between suture and periphery, usually alternating in strength; granules close-set, subcircular to roundly rectangular with long axis orthocline or more frequently opisthocline; intervals between granules narrower than granules themselves; subsutural cord frequently (not always) stronger than others, if so then its granules axially elongate-quadrate; intervals between spiral cords more or less equal to width of cords and sculptured by close-set prosocline axial pliculae (Fig. 12); peripheral spiral cord of early whorls frequently slightly below the periphery on body whorl, but nonetheless

delimiting boundary between apical surface and base. Base with *ca* 7 spiral cords between peripheral cord and umbilical margin; cords usually granular, but granulation sometimes nearly obsolete; when present granules close-set and rather flattened, those near umbilicus somewhat quadrate; intervals between cords of similar width to cords themselves and sculptured by prosocline pliculae. Umbilicus relatively wide, but spire portion filled with callus; umbilical margin angular and somewhat thickened by callus deposit, but deposit not extending on to base; umbilical margin with 6–8 small triangular denticles, the parietal one of which is not noticeably enlarged to form a tooth; parietal region covered with inductural callus deposit which develops weak ridges in fully mature specimens; interior of outer lip with 10–12 spirally aligned ridges, the uppermost one of which is not obviously larger than others; ridges not extending far inside aperture; internal margin of outer lip with additional small granules and ridge-like denticles, sometimes aligned with inner spiral ridges, sometimes not; basal columella tooth present, but simple and relatively small; columella slightly recurved, slender (compared to *Clanculus s. s.*); apertural margin of columella shallowly concave and smooth; upper portion of columella below disjunction with paries protrudes into aperture as a low triangular tooth (abapical upper columella denticle), no corresponding adapical denticle; disjunction of columella and paries shallow; interior nacreous when fresh, but most specimens losing iridescence with time.

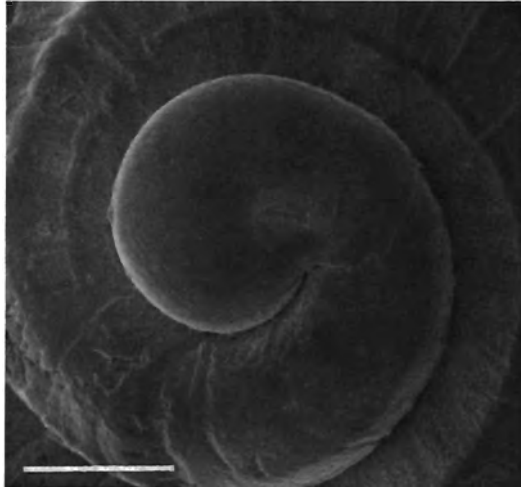


Fig. 70. *Clanculus mixtus* Smith, 1903, protoconch, NMSA S4423, bar = 100 μ m.

Protoconch (Fig. 70): Diameter 180–220 μ m; white or nearly so; apical beak present, but not large; terminal lip sinuous, not thickened and with no subterminal varix; badly eroded or missing in most specimens.

Colour: Early whorls translucent white or near white; spiral cords become dotted with spirally elongate, brown spots from end of second whorl onward, ground sometimes suffused with pale pinkish brown at this stage; pattern of spotting not

obviously linked to cord granulation; adapical surface of later whorls with more deeply pigmented ground, brownish in most specimens, but distinctly pinkish or purplish brown in others, usually mottled in deeper shades of the same colour; pattern variable, but frequently with a series of bold blotches or flames below the suture and a spiral row of smaller blotches of a similar colour at the periphery; base mottled or spotted with similar colours, often more boldly marked near umbilicus; umbilicus white.

Dimensions: Largest NMSA specimen, length 10,1 mm, diameter 12,1 mm; smallest specimen with mature apertural dentition, length 8,4 mm, diameter 9,8 mm.

Operculum: Unknown.

Radula and external anatomy: Unknown.

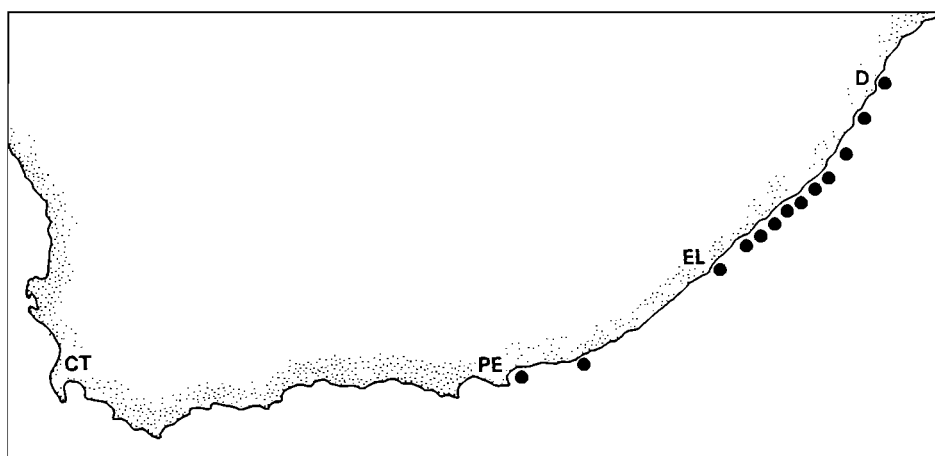


Fig. 71. Map showing the distribution of *Clanculus mixtus* Smith, 1903; each black circle represents one or more records. CT = Cape Town; D = Durban; EL = East London; PE = Port Elizabeth.

Distribution (Fig. 71): Durban south to Algoa Bay. I know of no live-taken specimens. Most material has been obtained from beach drift; occasional specimens have been dredged in water as deep as 190 m, but these shells probably belong to old deposits. The species is most abundant in Transkei, becoming scarce in Natal and the eastern Cape. More material is needed from Algoa Bay to confirm the existence of the species in the area of the type locality, Port Elizabeth.

Locality data (all NMSA): NATAL: Durban, found in reclamation sand dredged off Durban Bluff, 20–22 m, RK & R. Fregona (B5447); Durban, collected from reclamation dump sand dredged off Durban Bluff, 18–20 m, RK & DH (B8948); Scottburgh, H. Burnup (A4560); off Stiebel Rocks, near Phumula, hand-dredged sand, ± 20 m, dived DH (S9369); Port Shepstone, H. Burnup (1215, 2087, A900); Shelly Beach, near Port Shepstone, RK (9022), J. Marais (S4427); Leisure Bay, J. Marais (S4425). TRANSKEI: Pondoland coast, A. Filmer (*ex* H. Becker coll'n) (B6843); do, RK (A2332); Mzamba, beach drift, RK & DH (B4595, D2981); do, J.

Marais (S4423, S4424, S8343); between Mzamba and Mtentu Rivers, J. Stannard (E5986); Mkambati area, Mgwetyana River mouth, RK *et al.* (C5677); Msikaba Island, north side, RK *et al.* (C5571); Port Grosvenor, rock pools at LWST, RK & J. McKay (B926); Mbotyi, beach drift, RK & DH (C8265); off Mgazi River, 180 m, soft mud, dredged NMDP (C3052, E282); Shelly Beach, Hluleka, RK (C1495); Lwandile–Mdumbi area, RK & R. Fregona (C106); off Whale Rock, 20–26 m, sand and gorgonians, dredged NMDP (C3240, E260); Coffee Bay, RK (S372); Xora, beach drift, J. Marais (S4426); Nthlonyane, east of river mouth, beach drift, RK & J. Gould (B1483); Banyana River area, east of Mbashe River, RK (B1326); Dwesa, beach drift, RK (C6117); off Stony Point, 192 m, rocks of consolidated shell, dredged NMDP (C4378); Sandy Point, RK *et al.* (C3693). EASTERN CAPE: East London, C. Connolly (A5452); Port Alfred *ex* H. Becker coll'n (1214); do, H. Burnup (8616); do, J. Hutt coll'n (S4432).

Type material: The type material of Sowerby's *Clanculus waltonae* was evidently a mixture of two species. Realizing this, E. A. Smith separated out the second species in 1903, naming it *C. mixtus*. Four syntypes of *C. mixtus* are present in the BMNH (1899.4.14.2175–8), one, the figured specimen, is here designated lectotype (Figs 66–69).

Remarks: This species has been much confused with *C. waltonae* in the past, but the two can be easily separated by examination of the granules on the spiral cords. In *mixtus* these are close-set and rounded, and are generally either orthocline or opisthocline (Fig. 12); in *waltonae* they are more scale-like and always prosocline (Fig. 13). Both species have distinct axial pliculae in the cord intervals and these are much more numerous than the cord granules. However, in *waltonae* the pliculae are rather uneven and frequently raised to form thin, lamellate ridges in fresh specimens; in *mixtus* they are more regular and never lamellate.

C. mixtus is perhaps most similar to *C. cruciatus* (Linnaeus, 1758), type species of *Clanculopsis*; that species, however, is generally smaller, more elevated, has distinct spiral lirae in the cord intervals, a narrower umbilicus bounded by a strongly raised spiral cord which is coarsely denticulate in mature specimens, and has stronger teeth below the columella disjunction. *C. santamariae* and *C. pseudocorallinus*, described by Gofas (1984) from southern Angola, are superficially similar to *C. mixtus*, but both have much stronger apertural dentition more reminiscent of *Clanculus s.s.*

The absence of live-taken material, even from Transkei where *C. mixtus* commonly washes ashore in fresh condition, is surprising as the region has now been sampled extensively by the Natal Museum, both intertidally and by dredging. This indicates that the species is probably an inhabitant of near-shore, shallow, subtidal, rocky reefs, a habitat which has yet to be sampled in Transkei. Two specimens are available from muddy deposits in deep water (200–300 m) off the Matigulu River mouth in Zululand. Although not in good condition they are almost certainly referable to *C. mixtus*. It is probable that they originated in past glacial eras when sea levels were lower and colder waters enabled the species to extend further north.

Etymology: From *misceo* (L.) – to mix; presumably referring to the mixture of species in Sowerby's type material of *C. waltonae* from which this species was described.

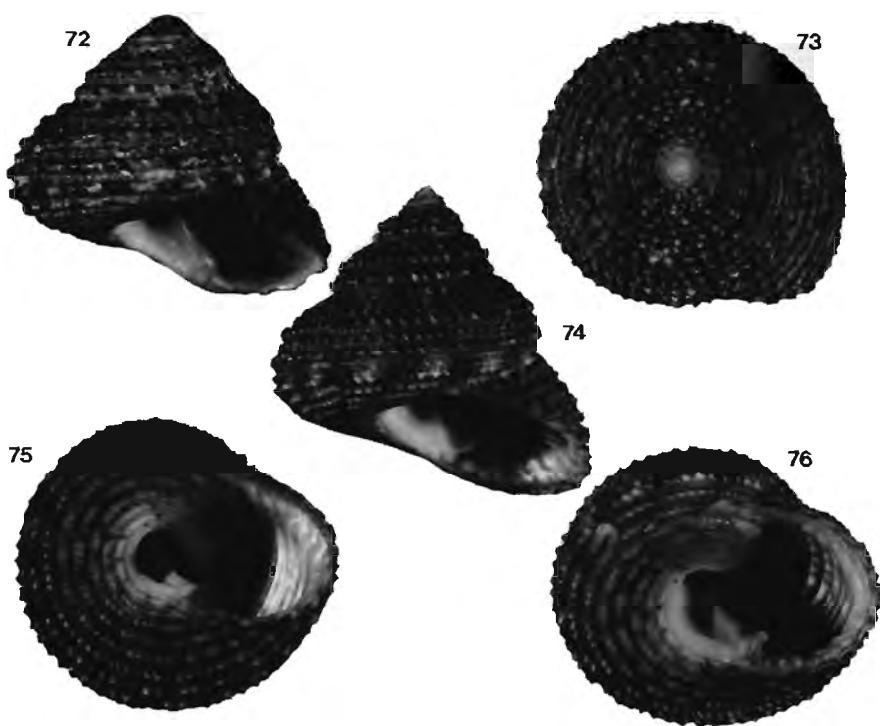
Clanculus (Clanculopsis) waltonae Sowerby, 1892

Pl. 1g, Figs 13, 72–79.

Clanculus waltonae Sowerby, 1892: 45, pl. 2, fig. 45; Bartsch, 1915: 151; Turton, 1932: 180, N° 1265; Barnard, 1963: 249; Kensley, 1973: 38, N° 74; Kaicher, 1980: 2280; Springsteen, 1981: 4, fig. 4.
Type loc.: Port Elizabeth.

Clanculus miniatus (non Anton, 1838); Turton, 1932: 178, N° 1258, pl. 42.

Diagnosis: Shell small, trochoid-turbiniform; sutures impressed and somewhat channelled; periphery more or less rounded; granules on spiral cords scale-like and almost invariably prosocline; interval pliculae well developed, usually lamellate, not gemmate; basal columella tooth of moderate size, simple; umbilical margin with low denticles when mature; shell orangish-brown or pinkish-brown with occasional darker spots or blotches.



Figs 72–76. *Clanculus waltonae* Sowerby, 1892. 72, lectotype, length 9,7 mm, diameter 11,2 mm; 73–76, unworn, live-taken specimen from south-western Transkei, NMSA C4216, length 11,5 mm, diameter 11,9 mm.

Description: Shell trochoid-turbiniform, ($L/D = 0,89–0,98$); teleoconch of 5–6 whorls, whorls somewhat adpressed, suture impressed, but not markedly so, sometimes rendered canaliculate by uppermost spiral cord; spire whorls evenly conoid or slightly cyrtconoid, body whorl dropping away and descending below periphery at outer lip; periphery below mid-whorl; base somewhat flattened, umbilicate. First teleoconch whorl with three spiral cords, one at shoulder, one at

periphery and one between these; a fourth cord appears towards end of whorl, between shoulder and adapical suture, a fifth arises beneath this towards end of third whorl; further intermediaries may develop during subsequent whorls; body whorl with five major cords on adapical surface above and including periphery, their intervals usually with a weaker intermediary; development of intermediaries variable, specimens from Transkei generally with well-developed intermediaries which almost equal primary cords in size, Cape specimens frequently with strong, raised primary cords but weak or obsolete intermediaries. Relatively coarse, prosocline, axial pliculae develop during second whorl and thereafter; pliculae cross cords, rendering the latter granular; granules scale-like (lamellate) and distinctly prosocline in orientation, not gemmate (Fig. 13); intervals between granules relatively wide, more or less equal in width to the granules themselves; on later whorls axial pliculae of cord intervals generally more numerous than granules. Base with 6–10 spiral cords; intervals between cords equal to cords in width or wider, sculptured by close-set prosocline pliculae; cords near periphery granular, those near umbilicus somewhat flat-topped and almost smooth, at most weakly crossed by pliculae of intervals. Umbilicus of moderate width, deep, but innermost portion filled with callus; umbilical margin angular, bordered by a thickened cord bearing weak denticles in the most mature specimens, but often smooth or nearly so; parietal region covered with inductural callus which may develop weak ridges in fully mature specimens, parietal tooth usually present as a pleat-like fold; inductural callus not spreading around umbilicus; interior of outer lip with up to 12 spiral ridges, the adapical one of which is not obviously larger than the others; ridges not extending far inside aperture; internal margin of outer lip with additional small granules and ridge-like denticles, sometimes aligned with inner spiral ridges, sometimes not; basal columella tooth present, of moderate size and with a single central ridge; columella slightly recurved, slender (compared to *Clanculus* s. s.); apertural margin of columella concave and smooth; upper portion of columella below its disjunction with paries protrudes into aperture as a triangular tooth (abapical upper columella denticle); above this columella becomes much thinner and deeply concave; a narrow ridge-like adapical upper columella denticle may be present; disjunction of columella and paries not deep-set; interior nacreous when fresh, spiral sculpture of external surface visible through nacre.

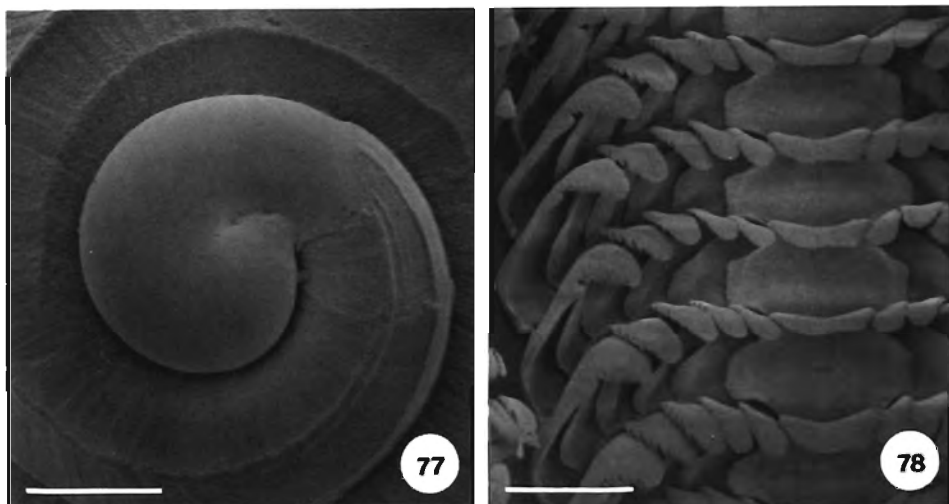
Protoconch (Fig. 77): Diameter *ca* 220–260 μm , white or nearly so; apical beak present but not large; terminal lip sinuous and very slightly flaring peripherally, not thickened and with no subterminal varix; missing or badly eroded in beach-drift material, but usually in relatively good condition in live-taken, dredged specimens.

Colour: Early whorls pale translucent brown or pinkish-purplish brown, some faint, slightly darker spotting may appear during third whorl; subsequent whorls with rather drab coloration – ground colour a pale shade of brown or pale orangish-brown, specimens from the Cape usually pinker; subsutural and peripheral spiral cords frequently with alternating light and dark spots of a similar orange-brown hue; some specimens with large dark subsutural blotches; base generally paler, spiral cords frequently with small brown or pinkish-brown spots; umbilicus white.

Dimensions: Largest NMSA specimen, length 11,4 mm, diameter 12,4 mm; smallest specimen with mature apertural dentition, length 8,5 mm, diameter 8,7 mm;

some specimens with a diameter of 10,0–10,5 mm may still lack apertural dentition.

Operculum: Corneous; multispiral (>12 whorls) with central nucleus; orange-brown; outer face glossy; growing margin narrow.



Figs 77-78. *Clanculus waltonae* Sowerby, 1892. 77, protoconch, NMSA C4266, bar = 100 μ m; 78, radula, left portion of central field, ex NMSA C4216, bar = 50 μ m.

Radula (Fig. 78): ± 60 transverse rows. Rachidian cusp broad, basal width of cusp more than half width of widest part of shaft/base-plate; cutting edge more or less straight, frequently slightly uneven, lateral margins of cusp oblique and finely denticulate. Laterals increasing slightly in size from first to fifth, cusps apically rounded with 4–6 small secondary cusps (denticles) basally on outer margin, inner margin finely serrate; outer margin of shaft of fifth lateral expanded, terminating distally as an additional cusp on outer margin at junction of main cusp and tooth shaft. Tooth overlap in central field extensive, but basal interaction of teeth evidently simple. Marginals similar to those of *C. miniatus*, but denticulation more pectinate.

External anatomy: Essentially similar to *C. puniceus*, but epipodial fold scarcely if at all fimbriate, epipodial sense organs lacking digitate processes and sides of foot not obviously papillate; snout flaring widely ventro-laterally; body much less vividly coloured (judging from preserved specimens), generally yellowish-white with numerous irregular black markings on head, snout and sides of foot; cephalic tentacles with longitudinal black line on dorsal surface. Ctenidium bipectinate; afferent membrane extending well beyond junction of transverse pallial vein.

Distribution (Fig. 79): Transkei, south and west to False Bay, beach drift to 165 m; living specimens known from 38–87 m, frequently associated with coarse sand and sponges.

Locality data (all NMSA): TRANSKEI (all dredged NMDP, dead, unless indicated otherwise): off Ubombo, living, 60–62 m, coarse sand, oyster shell conglomerate

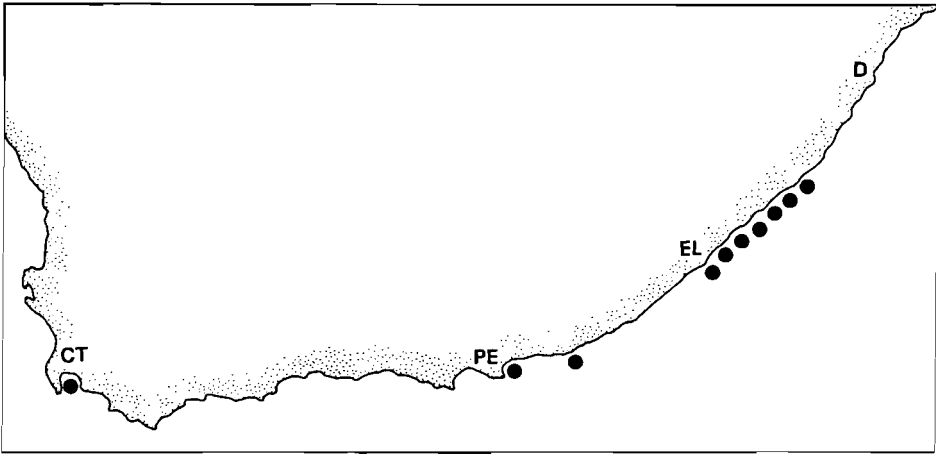


Fig. 79. Map showing the distribution of *Clanculus waltonae* Sowerby, 1892; each black circle represents one or more records. CT = Cape Town; D = Durban; EL = East London; PE = Port Elizabeth.

(C2472, E273); do, 135–165 m, sponge rubble (E271); off Mncwasa Point, 40–45 m, coarse sand (C2392); do, living, 68 m, sand (C2895); do, living, 74 m, sand and rubble (C2253, C2989, E228); off Bulungula River, 60 m, mixed fine sand and mud (C2519); off Nthlonyane River, 51 m, sandy mud, schizaminid foraminiferans (C2885, E161); off Mbashe River, 50–52 m, shell fragments (C1971); off Mendu Point, 48 m, fine sand (C4760); do, 66 m, coarse sand and rubble (C4799); off Qora River, 45 m, coarse sand and numerous hermit crabs (C4005); do, 75 m, moderately fine sand (C3897); off Stony Point, living, 87 m, coarse sand (C4266); do, living, 95 m, sponge rubble (C4216); off Sandy Point, living, 90 m, calcareous debris, coarse sand (C4562); off Kei River, living, 85 m, sponge rubble, coarse sand (C4954). EASTERN CAPE: off Gonubie, living, 38 m, sponges, soft corals and gorgonians, dredged NMDP (S4440); East London, C. Connolly (A5451, S5673); Port Alfred, J. Hutt coll'n (D2498); do, E. K. Jordan (B6589); Port Elizabeth, sea reserve, F. Graeve (A2649); Algoa Bay, RK (8618); Jeffrey's Bay, RK, F. Graeve (8617, B5577, A2624); do, dived J. Spiesser (S4441). WESTERN CAPE: False Bay, C. Connolly (A3264); do, Cape of Good Hope Nature Reserve, R. Bieler (B3458).

Type material: Two syntype lots are present in the BMNH, 1899.4.14.3594 and 1899.4.14.2171–4. The former contains a single specimen labelled as the 'figured specimen', but it is impossible, from Sowerby's very poor original figure, to confirm this. However, this specimen is marked X on the parietal region and the accompanying board states 'Port Elizabeth type X'. It is the largest of the syntypes and is here figured and designated lectotype (Fig. 72). Four of the specimens in Sowerby's original series represent a different taxon and became the types of *C. mixtus* Smith, 1903.

Remarks: Much confused with *C. mixtus* in the past (see remarks thereunder). *C. waltonae* is evidently a deeper water species and rarely washes ashore. Most beach drift material has originated in the Cape and none has been collected in Transkei despite this being relatively well sampled littorally. It is probable that the species occurs at shallower depths in the colder waters of the Cape.

Etymology: Named for Miss A. Walton, member of the Eastern Province Naturalist's Society (Kilburn & Rippey 1982).

Trochus Linnaeus, 1758

Trochus Linnaeus, 1758: 756, type species (s. d. Iredale, 1912: 225) *Trochus maculatus* Linnaeus, 1758.
Polydonta Schumacher, 1817: 231, type species *Polydonta granulata* Schumacher, 1817, proposed for "*Trochus maculatus* Lin.? *Trochus sanguinolentus grandinatus nicobaricus* Chemn. 5. pag. 83. Tab. 168. fig. 1615, 1616". Dodge (1958) has discussed the problems involved with the above names in detail. I follow him and most other recent workers in accepting "*sanguinolentus*" Chemnitz as a synonym of *maculatus*, and thus regard *Polydonta* as an objective synonym of *Trochus*. Schumacher's *Polydonta* should not be confused or thought to be homonymous with *Polydonte* Fischer von Waldheim, 1807 (Pulmonata: Ellobiidae).
Lamprostoma Swainson, 1840: 350, type species (monotypy) *Trochus maculatus* Chemnitz (listed by Chemnitz under *sanguinolentus grandinatus nicobaricus* [= *maculatus* Linnaeus, 1758]).

As with *Clanculus*, division of *Trochus* into well-defined subgenera is highly problematic. However, the two species of *Trochus* occurring in southern Africa can be referred to subgenera with reasonable certainty, one to *Trochus s. s.* and the other to *Infundibulops* Pilsbry, 1889.

Key to species of *Trochus* in southern Africa

- 1 Shell trochiform, sutures not impressed; umbilicus with well-developed spiral cord ending in middle of columella; interior of outer lip with spiral ridges in adult specimens **nigropunctatus**
- Shell trochoid-turbiniform, sutures impressed; no spiral cord in middle of umbilicus; adult specimens lacking ridges or denticles inside outer lip **cariniferus**

Subgenus *Trochus s. s.*

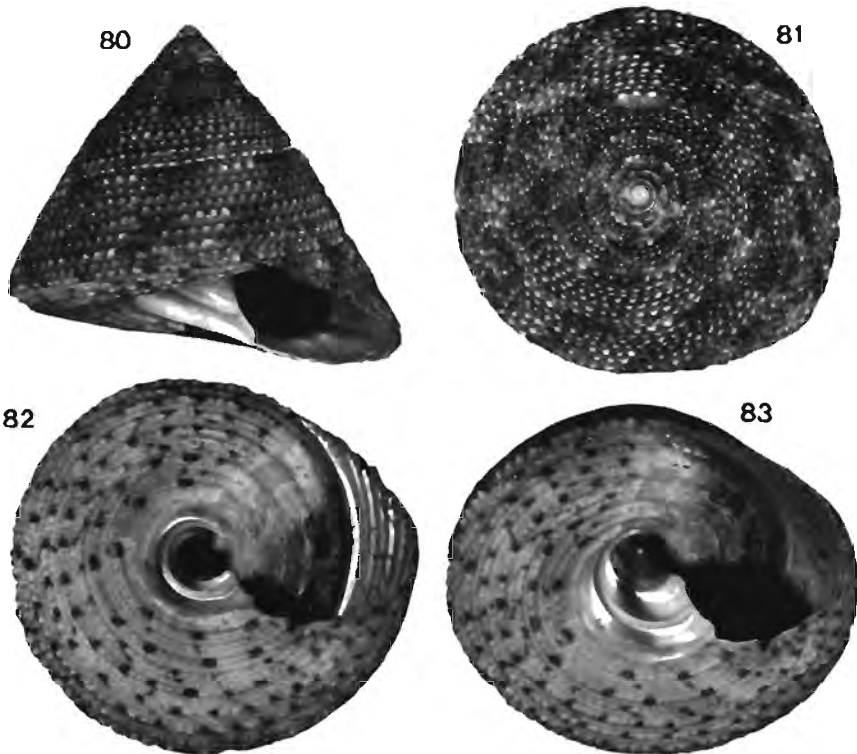
Diagnosis: Shell trochiform, sutures at most weakly impressed; periphery angular, base flattened; sculpture frequently of spiral cords and axial folds, often granulose; umbilicus present, but not patent to apex; columella disjunct at paries and strongly angled beneath this; columella lip typically with well-developed, fold-like denticles; interior of outer lip frequently with spiral ridges.

Trochus (Trochus) nigropunctatus Reeve, 1861

Figs 4, 80–89.

?*Trochus (Polydonta) subviridis* Philippi, 1848: 126; *idem*, 1855: 259, pl. 38, fig. 7. Type loc.: Unknown.
 ?*Trochus subviridis*; Philippi, 1855: 259, pl. 38, fig. 7; Pilsbry, 1889: 39, pl. 42, figs 4, 5.
Trochus hanleyanus (non Reeve, 1842); Krauss, 1848: 100, N° 19; Philippi, 1849: 95, pl. 16, fig. 2.
Trochus nigropunctatus Reeve, 1861: pl. 13, sp. 71; Pilsbry, 1889: 39, pl. 42, figs 2, 3; Barnard, 1963: 253, fig. 14b, radula; Macnae & Kalk, 1969: 45, 117, 127; Kilburn, 1970: 47; Kensley, 1973: 44, N° 109; Kaicher, 1979: 2135; Kilburn & Rippey, 1982: 42, pl. 9, fig. 6. Type loc.: Natal (Pilsbry, unjustifiably, considered this locality doubtful); restricted to Durban by Kilburn (1970).
Trochus (Polydonta) nigropunctatus; Sowerby, 1889a: 154.
Trochus (Infundibulum) nigropunctatus; Pilsbry, 1889: 39, pl. 42, figs 2, 3.
Trochus (Polydonta) nigropunctata; Sowerby, 1892: 44.
 ?*Trochus flammulatus*; (non Lamarck, 1822) Braga, 1952: 32, pl. 6, fig. 6; Paes da Franca, 1960: 55, pl. 1, fig. 9.

Diagnosis: Shell trochiform, sculptured with granular spiral cords and close-set axial pliculae; periphery never stellate; umbilicus wide and with *ca* three smooth spiral cords, plugged apically with callus; columella angled below disjunction with paries; ground colour pale with tinges of pink and/or green, patterned with axial bands of darker brown/black; base paler and with numerous finer black spots and dashes.



Figs 80–83. *Trochus nigropunctatus* Reeve, 1861. lectotype, length 24,5 mm, diameter 27,0 mm.

Description: Shell trochiform ($L/D = 0,80-0,93$), teleoconch of up to eight whorls, whorls flush and more or less flat-sided, sutures occasionally weakly indented giving a somewhat stepped profile; suture at periphery but sometimes descending on to base on last part of body whorl in fully mature shells or damaged shells; periphery sharply angled, well below mid-whorl, never stellate; base flattened, even slightly concave, umbilicate. First and second teleoconch whorls with four spiral cords, one at shoulder another level with abapical suture and two between these; intermediary cords arise during third and subsequent whorls; cords initially smooth, becoming granular during third whorl and developing prosocline pliculae in their intervals; pliculae more numerous than granules; body whorl with up to ten spiral cords between adapical suture and periphery, subsutural and peripheral ones often slightly stronger; cords sometimes weak and ill-defined on body whorl, often simply spiral rows of granules; granules round to ovate, orientation variable but usually consistent with in one

specimen. Intervals between cords approximately equal to or wider than width of one cord. Base with 6–10 first and second order spiral cords between periphery and umbilical margin with occasional very fine intermediaries; cords near periphery granular, those near umbilicus smooth. Umbilicus open but internally plugged with callus; umbilical margin a strong, smooth-edged cord; columella disjunct from paries and distinctly angled below its insertion into the umbilical callus (ie. at upper end of columella lip); angulation with a low spiral cord running from it into the umbilicus; a similar, but longer spiral cord lies between this and the umbilical margin, occasionally with a weaker intermediary between these last two; columella lip frequently toothed at end of umbilical spirals; umbilicus nacreous in fresh specimens; basal lip sharply angled at junction with columella, thin and smooth in the majority of specimens, but thickened in the most mature individuals and with *ca* 5 ridge-like denticles; outer lip smooth, sharply angled at periphery, interior with 4 (occasionally 5) spiral ridges when mature; parietal lip at most weakly callused, cording and patterning of preceding whorl showing through, occasionally with 1–2 weak spiral callus ridges; aperture quadrate, interior nacreous.

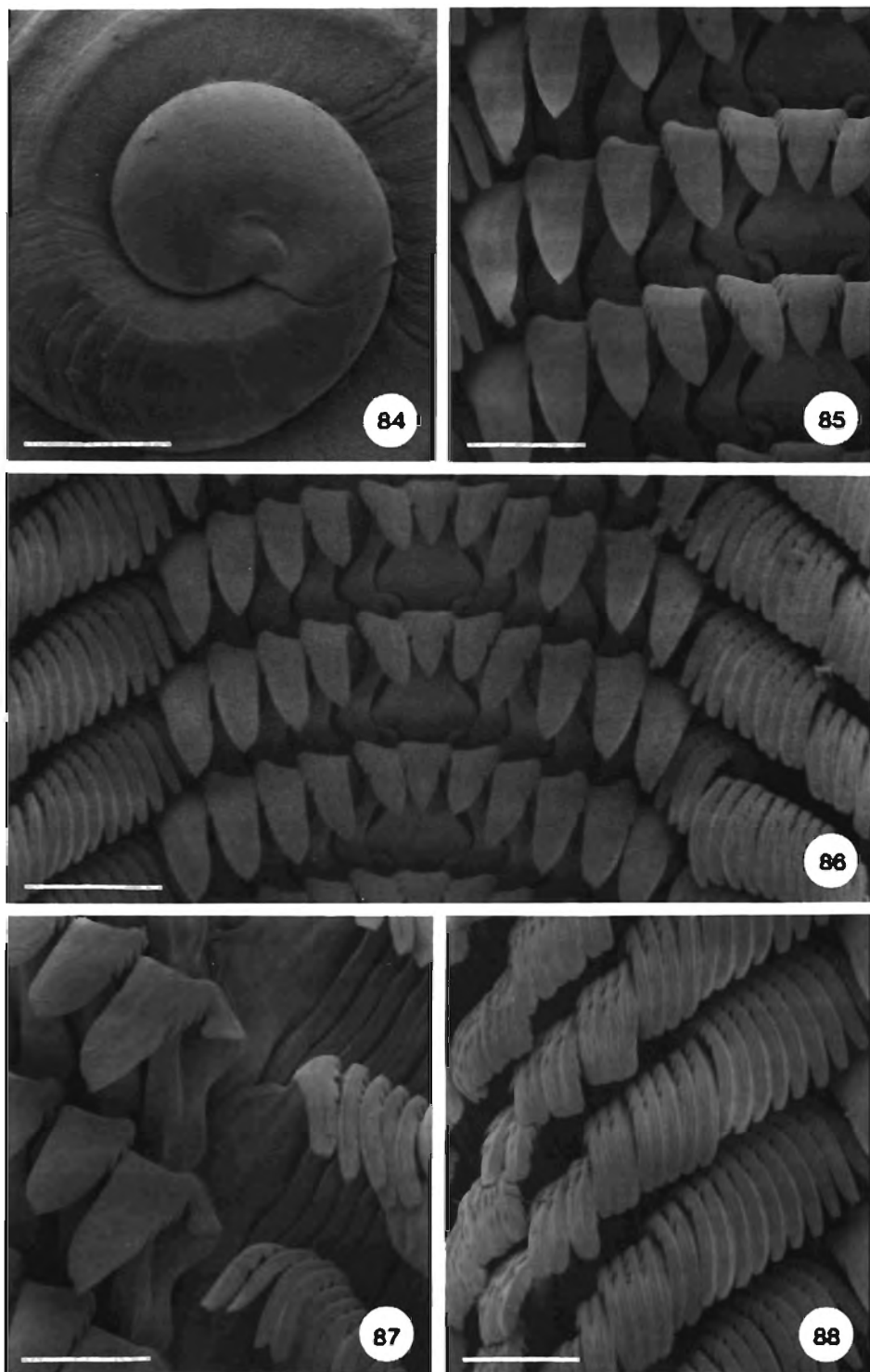
Protoconch (Fig. 84): Diameter ± 200 μm ; apex white or nearly so, becoming distinctly blue at junction with teleoconch; apical beak present; terminal lip sinuous, not thickened and with no subterminal varix; badly eroded or missing in most large specimens

Colour: Initial part of first teleoconch whorl blue, but quickly becoming pale yellow to fairly bright yellow; yellow colour fading toward end of second whorl and cords become spotted with spirally elongate deep brown dashes and blotches; intervals between brown marks generally near white on third whorl, but frequently tinged green, pink or yellow on subsequent whorls; blotches enlarging with growth and extending into intervals between cords and onto intermediary lirae; intervals with a green/yellow/pink iridescence when fresh. Adult colour pattern of broad brown/black axial bands on a paler ground, frequently tinged with pink and/or green; base lighter, cream to pale fawn-pink with numerous fine black spots on the spiral cords; black markings sometimes present as zig-zag radial flames; umbilicus white, its marginal cord occasionally tinged green or pink.

Dimensions: Largest NMSA specimen, length 27,7 mm, diameter 31,9 mm.

Operculum: Corneous; multispiral (>10 whorls), with central nucleus; yellowish-brown to deep orange-brown; outer face semi-matt to glossy; growing margin narrow.

Radula (Figs 85–88): 60–70 transverse rows; formula $\infty + 5 + 1 + 5 + \infty$; rows evenly curved, no obvious posterior dip in the mid-line. Rachidian cusp trigonal, comprising a central subtriangular element (the main cusp) and 3–4 secondary cusps basally on each side; base of cusp not indented in mid-line as in *Clanculus* species; shaft/base-plate expanded laterally, but width not more than twice that of cusp. Cusps of lateral teeth asymmetric, elongate and bluntly pointed; outer margin with 3–5 secondary cusps at base; inner margin evidently smooth. Basal interaction of teeth in central field more complex than that in *Clanculus*; visible portion of shaft/base-plate modified to form a raised, ridge-like frontal element; frontal element skewed laterally near base and interlocking with corresponding socket on median portion of its outer



Figs 84–88. *Trochus nigropunctatus* Reeve, 1861. 84, protoconch, NMSA S4109, bar = 100 μ m; 85–88, radula, ex NMSA D5586; 85, rachidian and left laterals, bar = 100 μ m; 86, central field and inner laterals, bar = 150 μ m; 87, latero-marginal area, bar = 100 μ m; 88, marginals, bar = 100 μ m.

neighbour; fifth lateral with well-developed, robust accessory cusp on outer margin of main cusp and with a distinct socket below this. Shaft and base plate of innermost marginal expanded along longitudinal radula axis; cusps of inner marginals somewhat scythe-like, with 2–3 basal denticles on outer margin and a central thickened ridge; cusps progressively less elongate and with more numerous, finer denticles toward edge of radula.

External anatomy (Fig. 4): Forehead wide with well-developed cephalic lappets, free margin of lappets finely divided into small, sometimes branching, micropapillate processes; cephalic lappets separate but overlapping slightly in the mid-line; cephalic tentacles prominent, micropapillate; eyestalks short, fused basally to cephalic tentacles, eye subterminal, black; right post-optic tentacle present in some specimens but evidently absent in others; snout broad, distally truncate and widely expanded ventro-laterally on both sides; oral disc essentially D-shaped, but flaring ventro-laterally, lips with irregularly radiating folds and split mid-ventrally; left neck lobe broadest anteriorly, tapering smoothly into epipodial fold posteriorly, anteriorly disjunct from eyestalk, margin beset with numerous slender, micropapillate, digitiform processes; upper surface of lobe with close-set somewhat irregular, transverse folds; right neck lobe similar to left one but anteriorly fused to base of right eyestalk, dorsal surface more or less smooth and free margin less deeply divided; underside of right neck lobe with a thickened ridge anteriorly, between eyestalk and epipodial sense organ. Epipodial fold well developed, free edge fimbriate; four (occasionally five) micropapillate epipodial tentacles on each side, one immediately posterior to neck lobe, one at anterior edge of operculum and two beneath operculum; epipodial sense organs present near base of each epipodial tentacle and one beneath each neck lobe, each sense organ raised on short stalk which expands dorsally over sense organ as a papillate hood; sense organ beneath first epipodial tentacle usually displaced somewhat posteriorly to lie between first and second tentacles (particularly so on right); epipodial fold continues posteriorly beyond operculum and joins in mid-line. Sides of foot made rugose by numerous close-set papillae; foot (in preserved specimens) truncated anteriorly, roundly tapering posteriorly; sole grooved longitudinally in the mid-line with numerous transverse folds; dorsal portion of foot posterior to operculum flattened and bearing a longitudinal glandular slit in the mid-line.

Animal for the most part near white; head usually with some black pigmentation, particularly on snout; cephalic tentacles uniformly greyish; sides of foot mottled with black, frequently forming a more or less continuous dark line above the margin of the sole.

Ctenidium bipectinate almost throughout (only very short portion at posterior monopectinate), afferent ctenidial membrane long, extending well beyond junction of transverse pallial vessel, anterior $\frac{1}{4}$ – $\frac{1}{8}$ of ctenidium free.

Distribution (Fig. 89): Southern Mozambique to eastern Cape Province, most common in southern Natal and Transkei; primarily an inhabitant of rocky intertidal areas, living from mid to low tide level, in pools, shaded crevices and under rocks, often in groups. The single dead specimen dredged in 74 m off Lala Nek, Zululand, was presumably washed to this depth from shallower water.

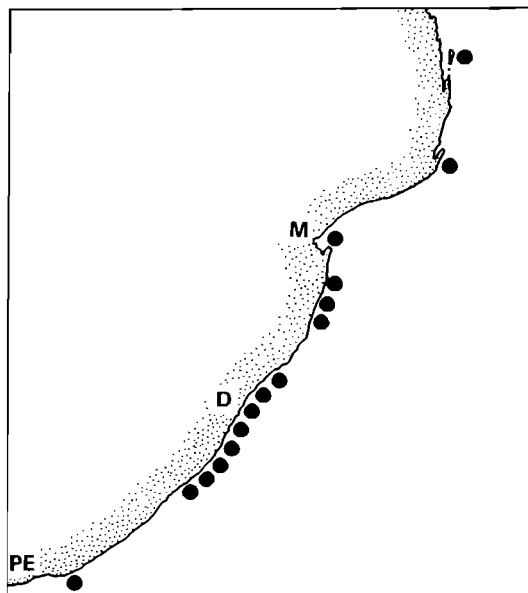


Fig. 89. Map showing distribution of *Trochus nigropunctatus* Reeve, 1861; each black circle represents one or more records. M = Maputo; D = Durban; PE = Port Elizabeth.

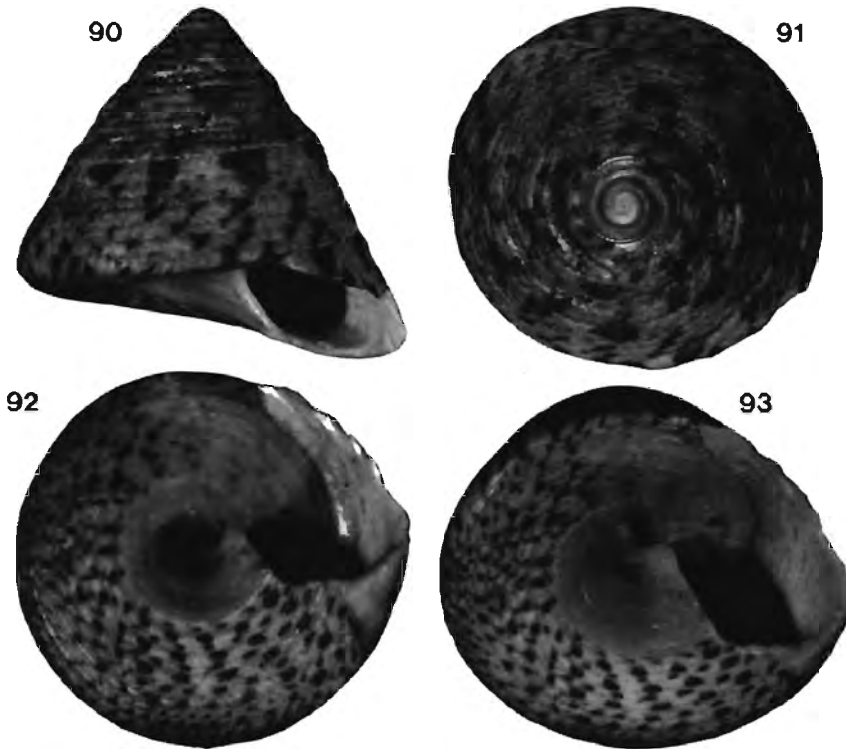
Locality data (all NMSA): MOZAMBIQUE: Bazaruto Island (4432); Cabo das Correntes, Jangamo, R. Cruickshank (F7018); Cabo de Santa Maria, Delagoa Bay, R. & E. Kilburn (6181); ZULULAND: Kosi Bay, W. Haacke (B1113); do, *ex* B. J. Young coll'n (B2375); Boteler Point, intertidal rocks, DH *et al.* (D9652); Black Rock, beach drift at exposed intertidal outcrop, DH *et al.* (S851); off Lala Nek, 74 m, shells, sand, dredged NMDP (S7419); Jesser Point, exposed rocky reef, RK & DH (D5741); Leven Point, beach drift, RK & DH (D5534); Cape Vidal, exposed rocky reef, RK & DH (9437, D5674, D5870 living); off Cape Vidal, 30 m, medium sand and shells, dredged NMDP (E3524); Mission Rocks ± 9 miles north of St Lucia, R. & E. Kilburn (9275); Mission Rocks/Perrier Rocks, littoral, living, RK & DH (D5586); NATAL: Mvoti River mouth, R. & E. Kilburn (9361); Salt Rock, among oysters on side of intertidal swimming pool in 1–2 ft, RK (A182); Shaka's Rock, intertidal zone, DH (D495); do, rocks in front of swimming pool, R. & E. Kilburn (9441); Vetch's Pier, Durban, living, dived 2–4 m, DH (D1713); Treasure Beach, near Reunion Rocks, under rock in sheltered bay, T. Stewart (E8448); Reunion Rocks, intertidal zone, RK, DH & R. Fregona (D366, S4442 living); do, R. & E. Kilburn (8409); Lower Umkomaas, H. Burnup (6348); Clansthal, *ex* W. Falcon coll'n (6350); Scottburgh, J. Marais (S4429); Kelso Beach, *ex* B. Young coll'n (B2373); Mtwalume, rock pools, RK & DH (B8627); do, R. & E. Kilburn (9465); Hibberdene, living, R. & E. Kilburn (S4444); Banana Beach, living in intertidal swimming pool, DH (D2260); Port Shepstone, H. Burnup (6351); Shelly Beach, south of Port Shepstone, W. Rump (6349, 7888); do, RK (A1607); Mbango, south of Port Shepstone, intertidal rocks, living, DH & M. Mander (S4109); Trafalgar

Marine Reserve, intertidal rocks, F. Junor (E1884); Trafalgar, living, RK & DH, S. Reynders (D3133, B2055); Palm Beach, J. Marais (S4428); Glenmore Beach, south of Tongazi River mouth, intertidal rocks, DH & M. Mander (S4129); T. O. Strand, 2 km north of Port Edward, RK & DH (D3092); Port Edward, *ex* B. Young coll'n (B2374). TRANSKEI: 'East Griqualand', A. Filmer (B1111); Mzamba, beach drift RK & DH (D2975); do, RK & R. Fregona (B4449); Mkambati, Mgwetyana River area, RK *et al.* (C5611); Msikaba Island, north side, RK *et al.* (C5538); do, living among low tide rocks, RK (B4954); Port Grosvenor, rock pools at LWST, RK & J. McKay (B924); Mbotyi, DH & RK (C8269); do, RK & J. McKay (A4783); Mbotyi west, under rocks at LWST, RK & J. McKay (A5206); off Rame Head, 26–30 m, fine sand, dredged NMDP (C2166); Port St John's, N. Gould *ex* Albany Mus. (B7343); Hluleka, DH (D4459); Hluleka, Shelly Beach, RK (C1496); Lwandile/Mdumbi area, RK & R. Fregona (C74); Coffee Bay, Y. McLellan (B6257); Nthlonyane River, beach drift east of river, RK & J. Gould (B1386); Banyana River area, east of Mbashe River, RK (B1204); Mbashe River area, RK (B5517); Dwesa, beach drift, RK (C5917). EASTERN CAPE: Port Alfred, J. Hutt coll'n (D2493).

Type material: Three syntypes are present in the BMNH (reg. no. 1968622). These are in good condition and were obviously collected alive. None is obviously the figured specimen and, though large, none has fully developed apertural dentition. Nevertheless, all are typical examples of the species and one is here designated lectotype (Figs 80–83).

Remarks: Kilburn (1970), judging from Reeve's original figure, concluded that *Trochus textilis* Reeve, 1861, supposedly from the 'Cape of Good Hope', was a synonym of *nigropunctatus*. However, the locality given for *textilis* was questioned as early as 1889 by Pilsbry (1889: 38) and examination of the holotype in the BMNH (reg. no. 1968616) (Figs 90–93), even though it is somewhat worn, indicates that two separate species are involved. *T. textilis* differs from *T. nigropunctatus* in being more elevated ($L/D = 0.93$), in having obsolete spiral cords with poorly defined granules, in lacking distinct cords at the centre and margin of the umbilicus, and in having a more noticeably concave base with only weak spiral sculpture. Furthermore, the base is much more heavily patterned with red rather than black dots and the colour pattern in general comprises red maculations on a whitish ground with no black or green coloration. No material conspecific with *T. textilis* has been found in southern Africa and the type locality is clearly erroneous. The true origin and relationships of *T. textilis* remain to be established.

Pilsbry (1889) placed *T. subviridis* Philippi, 1848, of unknown origin, in synonymy with *T. nigropunctatus*, but, rather puzzlingly, discussed the species under the younger name. Without examining the type material of *T. subviridis*, if this is still extant (none in ZMHB, personal observation), it is impossible to make a decisive comment on this and I prefer to maintain the long established and widely used name. Pilsbry also referred *T. nigropunctatus* to the subgenus *Infundibulum* Montfort, 1810, but Pilsbry's interpretation of trochine subgenera in general was different from that of more modern workers and, to my mind, the umbilical form of mature specimens and overall shell facies is typical of *Trochus s. s.*



Figs 90–93. *Trochus textilis* Reeve, 1861, holotype, length 20,0 mm, diameter 21,6 mm.

In specimens from Zululand and southern Mozambique the spiral cords are somewhat fewer and are more coarsely granular; the subsutural and peripheral ones of which are usually broader and more prominent, the area between frequently appearing concave, giving the spire a somewhat stepped profile. Furthermore, in these northern specimens, the black spots on the base are commonly interconnected, forming zig-zag radial lines, and there is frequently a pinkish wash in the colour pattern.

In captivity, living specimens of *T. nigropunctatus* have been observed to curl the posterior of the foot around the shell periphery and 'wipe' the shell. A similar behaviour has been noted in *Calliostoma* by Jones (1984), although in *T. nigropunctatus* the foot seems to be less mobile and is not extended far on to the adapical surface. Jones speculated that an antifouling substance produced by glands on the postero-dorsal surface of the foot was applied to the shell during this behaviour. It is noteworthy that the shell of *T. nigropunctatus* is generally free of encrustations on the base and periphery, but the apical surface is often encrusted with algae, barnacles and tubicolous polychaetes.

Etymology: From *niger* (L.) – black, and *punctum* (L.) n. – a little hole, dot or point.

Subgenus *Infundibulops* Pilsbry, 1889

Infundibulops Pilsbry, 1889: 8, type species (o. d.) *Trochus erithreus* Brocchi, 1821 (= *erythraeus* auctt).

Distinguished from *Trochus* s. s. by the lack of spiral cords in the umbilicus and the absence of denticles on the columella. Close to *Infundibulum* Montfort, 1810, type species *Trochus concavus* Gmelin, 1791, but differs in lacking a distinct angle on the columella below its insertion into the umbilicus.

Trochus (Infundibulops) cariniferus Beck in Reeve, 1842

Figs 5, 94–108.

Trochus cariniferus "Beck MSS?" in Reeve, 1842: 165, pl. 218, fig. 8; Philippi, 1855: 258, pl. 38, fig. 6, and pl. 43, fig. 4; Fischer, 1877: 229, pl. 75, figs 1, 2; von Martens, 1879: 735; Pilsbry, 1889: 41, pl. 5, figs 38–42; Yen, 1942: 179; Cotton, 1959: 90; Kaicher, 1979: 2096; Drivas & Jay, 1988: 34. Type loc.: non given, here designated Mozambique Is.

Infundibulum cariniferum; A. Adams, 1853: 152.

Polydonta (Infundibulum) concinnum A. Adams, 1855: 132, No. 11; Pilsbry, 1889: 46. Type loc.: China Seas. **Syn. n.**

Trochus (Polydonta) cariniferus; von Martens, 1880: 295.

Trochus (Infundibulum) baccatus Sowerby, 1889b: 397, pl. 25, figs 8, 9. Type loc.: Mauritius. **Syn. n.**

Trochus (Infundibulops) cariniferus; Lamy, 1909: 331; Smith, 1910: 205; Haas, 1954: 46; Kilburn, 1972: 394.

Trochus (Infundibulops) carinifer; Dautzenberg, 1929: 536(330).

Infundibulops cariniferus; Spry, 1968: 7.

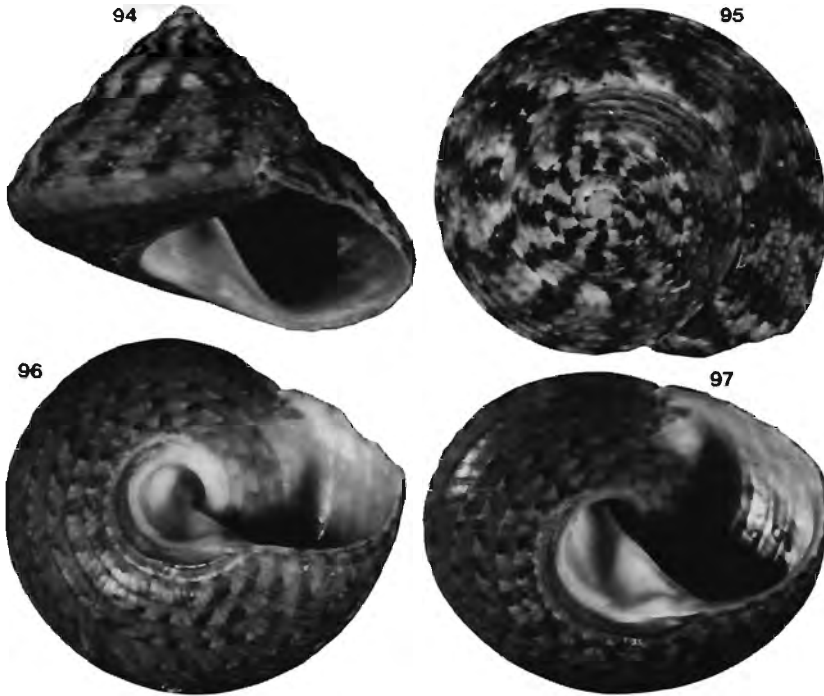
?*Trochus* sp.; Moura, 1972: 22, pl. 2, fig. 7.

?*Trochus (Trochus) radiatus* (non Gmelin, 1791); Moura, 1976: 50, pl. 2, fig. 1a, b.

?*Trochus wilsi* Pickery, 1989: 1, figs 1–3. Type loc.: Eilat, Gulf of Akaba, Israel.

Diagnosis: Shell trochiform, but whorls frequently convex; sculptured with granular spiral cords; periphery never stellate; umbilicus wide, lacking spiral cords except for a smooth marginal cord; interior of umbilicus plugged apically with callus; columella without a distinct angle below its insertion into the umbilicus; apical whorls with red spiral lirae, remaining shell generally red or axially banded, blotched or spotted in green and red or green and white.

Description: Shell trochiform ($L/D = 0,72\text{--}0,92$), teleoconch of up to seven whorls; spire sometimes flat sided, but more often sutures slightly indented and whorls somewhat convex; spire usually a little cyrtconoid; suture level with periphery, not descending on to base on last part of body whorl; periphery roundly to distinctly angled, below mid-whorl, never stellate; base flattened, but remaining convex, umbilicate. First and second teleoconch whorls rounded, first with four spiral cords, second with 5–6; fine intermediary lirae may arise during third and subsequent whorls; cords initially smooth, becoming granular during third or fourth whorl; granules round, subquadrate or rectangular; body whorl with 5–6 first order spiral cords between adapical suture and periphery, subsutural one occasionally stronger than others; intervals more or less equal to width of cords, frequently sculptured with intermediary cords and/or lirae; cords and granules sometimes weak and ill-defined on body whorl. Axial sculpture variable in strength and somewhat irregular, comprising coarse and fine collabral growth-lines, some specimens with at most fine axial pliculae in the cord intervals. Base with 5–7 broad, flat, spiral cords between periphery and umbilical margin; cords wedge-shaped in profile, the peripheral edge thicker, generally without granules; intervals rarely with intermediary spirals, for the

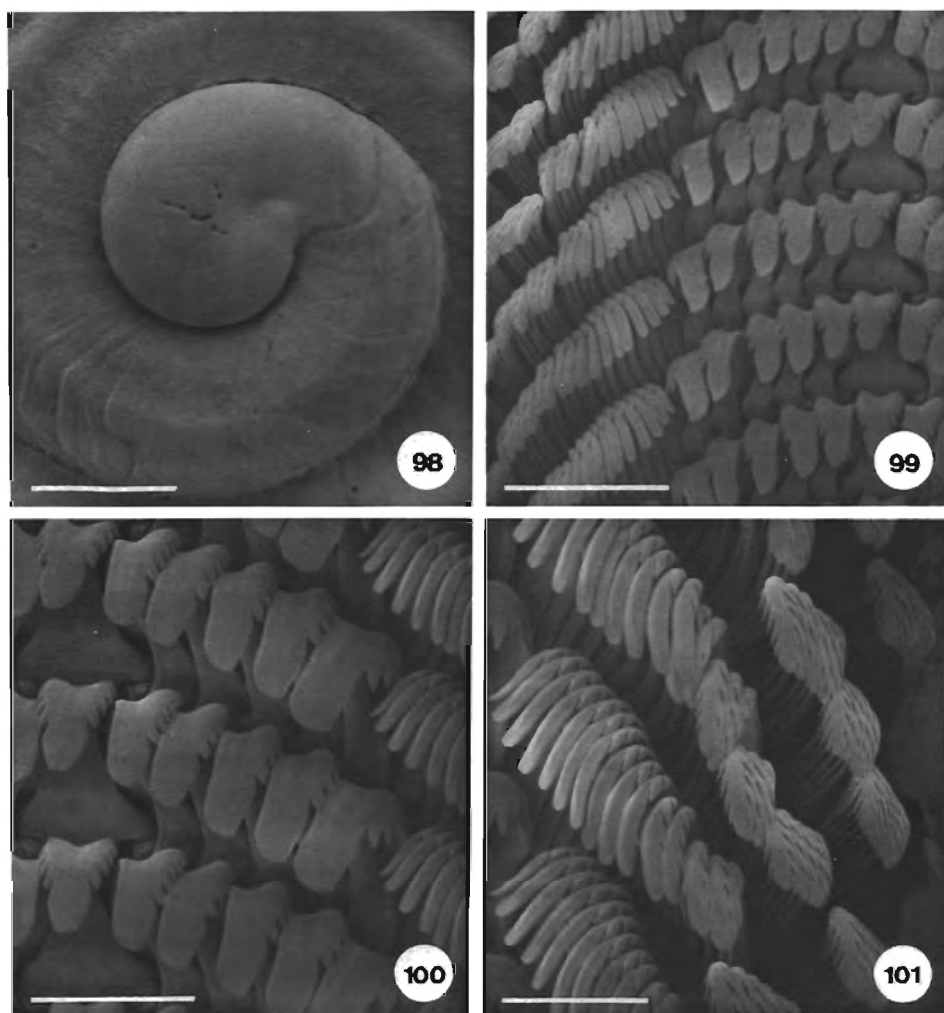


Figs 94–97. *Trochus cariniferus* Beck in Reeve, 1842, neotype, length 17,5 mm, diameter 21,7 mm.

most part sculptured only by fine growth-lines. Umbilicus open, but internally plugged with callus, nacreous when fresh; bordered by a strong, smooth-edged cord, but with no further spiral cords inside; columella disjunct from paries, slightly excavated below its insertion into the umbilicus, but lacking a distinct angulation; marginal cord of umbilicus sometimes ending as a small tooth on the columella lip; outer lip angled at junction with columella, generally thin and only slightly thickened even in most mature specimens; labial denticles absent. Aperture quadrate; interior nacreous, cording of external surface often visible through nacre; large specimens very occasionally with ± 6 spiral ridges on interior above periphery; parietal lip with a thin transparent glaze.

Protoconch (Fig. 98): Diameter $\pm 200 \mu\text{m}$; white; similar to that of *T. nigropunctatus*.

Colour: Coloration of early teleoconch whorls similar in all specimens but subsequent coloration immensely variable. First half of first teleoconch whorl white, but spiral cords becoming vivid red in second half; cords similarly coloured on second whorl, but colour usually interrupted in axial bands and ground colour showing through. In typical morph red coloration of early spiral cords persists and axial bands of ground colour turn green with growth; adult pattern of somewhat irregular, alternating bands of brownish-red and green. Specimens from Natal and Zululand are nearly always of this form. The *concinus* colour variation is quite distinct with red coloration of early whorls rapidly becoming dark greenish; adult pattern on adapical surface comprising broad, dark brownish-green axial bands on a pale greenish-white



Figs 98-101. *Trochus cariniferus* Beck in Reeve, 1842. 98, protoconch, bar = 100 μ m; 99-101, radula *ex* NMSA E2480; 99, left side, bar = 150 μ m; 100, rachidian and right laterals, bar = 100 μ m; 101, marginals, bar = 75 μ m.

ground; the base has a spirally aligned series of dark green dashes on the thickened margins of each of the spiral cords. This form may also occur with deep purplish-brown markings. Another relatively discrete colour pattern is the *baccatus* form in which the coloured markings on both the adapical surface and the base take the form of numerous spots or dashes on the spiral cords, usually reddish-brown or purplish-brown on a much paler ground. Between these more or less recognisable extremes lies a wide range of intermediate patterns ranging from almost entirely red, through cream with red axial bands, to almost entirely green. In most specimens the axial banding is more pronounced apically. Umbilicus white or nearly so; cord at umbilical margin white or pinkish, never green, even in *concinus* colour form.

Dimensions: Largest NMSA specimen, length 19,9 mm, diameter 25,0 mm.

Operculum: Corneous, relatively thin; multispiral with a central nucleus; yellowish brown, outer face semi-matt to somewhat glossy; growing margin narrow.

Radula (Figs 99–101): ± 50 –60 transverse rows; similar to that of *T. nigropunctatus*, but cusps of teeth in central field more spatulate and blunt ending; secondary cusps on outer margin of teeth coarser; accessory cusp of fifth lateral not separated as a discrete entity, but outer distal portion of tooth shaft enlarged and secondary cusps relatively strong. The radula of *T. erithreus*, type species of *Infundibulops*, judging from the figure given by Bisacchi (1931), is very similar.

External anatomy (Fig. 5): Similar to that of *T. nigropunctatus*, but generally less rugose. Margin of left neck lobe less deeply divided and more similar to that of right lobe; epipodial fold essentially smooth; hoods of epipodial sense organs lacking distinct papillae. Animal for the most part near white, but head and sides of foot usually with some reddish or black pigmentation; cephalic tentacles dark with two unpigmented longitudinal stripes on dorsal surface. The “*concinus*” form has a transversely banded snout and dark V-shaped marks on forehead.

Distribution (Fig. 102): Islands of the western Indian Ocean and East Africa south to the Natal south coast. A single subfossil specimen from deep water (222 m) off the Kei River at the Cape/Transkei border was presumably washed out to this depth

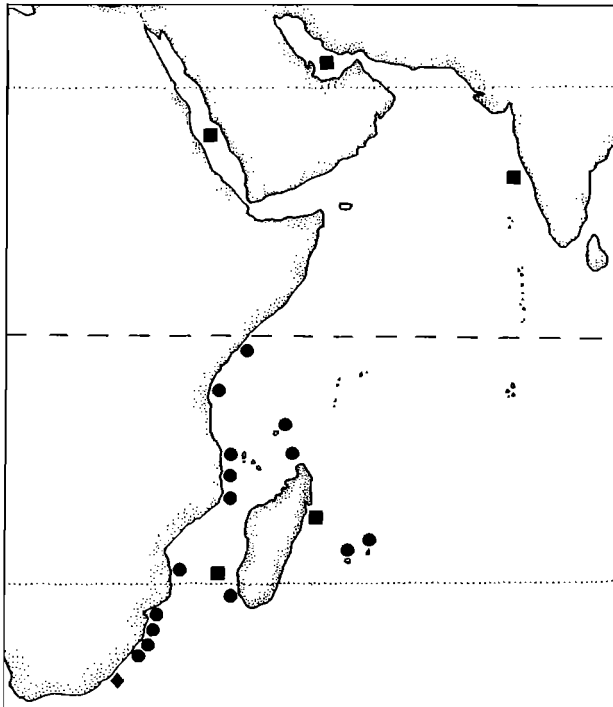


Fig. 102. Map showing distribution of *Trochus cariniferus* Beck in Reeve, 1842; black circles = material examined, black squares = literature records, black diamond = fossil record.

during the last interglacial when the range of many tropical species extended much further south. Also recorded from the Red Sea and India (von Martens 1880), the Persian Gulf (Haas 1954) and North Australia (Adams 1853, repeated by Cotton 1959), but these records require confirmation. The type locality of *Polydonta (Infundibulum) concinnum*, 'China Seas', is a notoriously vague and frequently erroneous locality.

An inhabitant of intertidal and shallow subtidal reefs in tropical and near tropical waters, where it may be found living under rocks and coral blocks.

Regional locality data (all NMSA): NORTHERN MOZAMBIQUE: Quirimba Island, E. Roscoe, RK (J9591, J9595, J9104, J9118); Porto Amelia (=Pemba), E. Roscoe, RK (F7036, G3496, G3501); Nacala Bay, 30 m, dredged M. Amorim (K9073, K9074); Mozambique Island, living, on jetty at LWST, RK, A. Enes (K7535, K7536, G3458); Conducia Bay, K. Grosch (numerous lots). SOUTHERN MOZAMBIQUE: Bazaruto Island, K. Eastwood (F5235); do, Gengareme, E. Roscoe (G884); do, northern tip of island, E. Roscoe (J9593, J9589); Santa Carolina Island, west reef, E. Roscoe (G97, G100); do, $\frac{1}{2}$ mile west of island, dredged in 6 m, sand and shell debris, E. Roscoe (J9590); S. W. of Santa Carolina Island, trawled in 0.6 m, E. Roscoe (J9592); Inhagondo, Anchor Reef, E. Roscoe (G2094); Inhaca Island, R. & E. Kilburn (6182). ZULULAND: Kosi Bay, B. J. Young coll'n, (B2394); Kosi Bay, main reef 1–4 km south of estuary mouth, 9–22 m, dived DH *et al.* (D9245, S1065); between Bhanga Nek and Kosi Bay, reef off marker 13 north, northern portion, dived 4–10 m, DH *et al.* (S946); do, ± 13 m, hand dredged sand, dived DH (S3015); do, algal portion, dived 5–9 m underwater pump, DH & K. Bloem (S2850); do, N° 13 Reef, living, 6–18 m, dived DH *et al.* (D9510); Boteler Point, intertidal rocks, living, DH *et al.* (S1575); Sodwana Bay, S. Reynders (A1212); do, Nine-Mile Reef, 10–18 m, dived DH (D3220); do, Two-Mile Reef, living, 10–15 m, dived DH (D1728, D1820, D3309, D5113); do, sorted from stone washings, dived 10–15 m, DH & R. Broker (E736); do, Algae Reef, dived 6–12 m, DH, R. Broker & M. Mander (E583); Leadsman Shoal, main portion of coral reef, living, dived 7–11 m, DH & NPB (E2480, E6762); do, outer portion of reef, sorted from stone washings, dived 24–26 m, DH & NPB (E2669); do, Raggie Reef, mixed algal and coral reef 1–2 km north of Leven Point, dived 9–14 m, DH & NPB (E2521); Leven Point, sorted from stranded coralline algal debris, DH (E2773); Cape Vidal, exposed intertidal reef, living, RK & DH (D5870, S4443); Mission Rocks, living, C. & M. Quickelberge (B7037); Mission Rocks/Perrier Rocks, littoral, living, RK & DH (D5585); off Matigulu River mouth, 200–220 m, mud, coarse sand, *Dendrophyllia*, dredged NMDP (E9025). NATAL: Durban Bay, dredged B. J. Young (A1399, B2393); Isipingo swimming pool, RK (B3433). TRANSKEI: off Kei River, 222 m, coarse sand and old shell debris, dredged NMDP (C4700).

Extra-limital locality data (all NMSA, unless indicated otherwise): KENYA: Mida Point, low intertidal, Bangor Watamu Expedition (BMNH); Kilifi, lagoon inshore of coral reef, hand-dredged sand at base of coral outcrops, ca 4 m, dived DH (K7634); Kilifi, intertidal, J. Bumpus, Bangor Watamu Expedition (BMNH); Shimoni, J. D. Taylor (BMNH). TANZANIA: Dar-es-Salaam, I. F. Lambert (F8566). ALDABRA: Aldabra, not further localised, J. D. Taylor (BMNH); Passe Femme, beneath coral

and sponge around islets, J. D. Taylor, Royal Society Exped. (BMNH A2222); many lots in BMNH wet collection (A2211) from numerous localities on Aldabra collected during the 1967-8 Royal Society Exped., all of the *concinus* colour form. GLORIEUSE: Glorieuse, not further localised (BMNH). MADAGASCAR; H. Becker coll'n (H6137); Tuléar, Mora Mora, B. J. Piech (K7020). RÉUNION: Boucan Canot, 50 m, sand and stones, dredged J. Drivas (K3033).

Type material: There are four "probable syntypes" of *T. cariniferus* present in the BMNH (reg. no. 1844.6.3.448). I know of no other type material in existence and because there is evidently some doubt as to whether or not these specimens are truly the types, I here select one as neotype. The original figure given in Reeve shows a specimen with relatively narrow, red, axial flames, and as only one of the types is so coloured I choose it as neotype (Figs 94–97); dimensions, diameter 21,7 mm, length 17,5 mm. The other specimens have either broad, dark green/brown axial rays, or lack a distinct axial colour pattern.

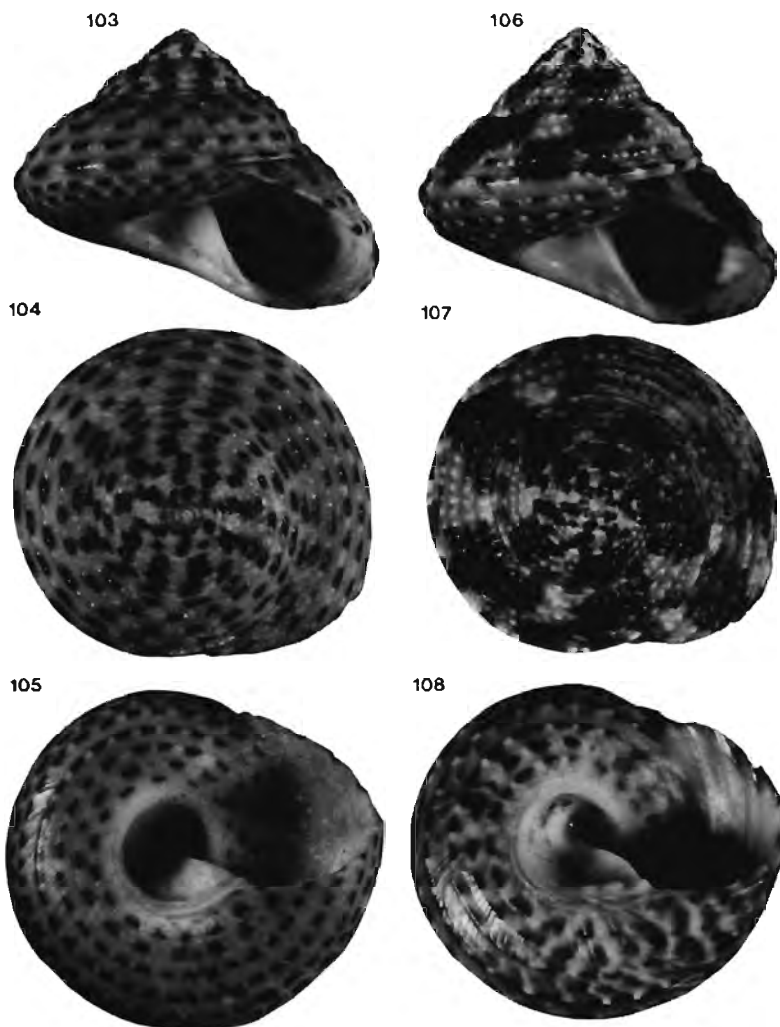
Five syntypes of *T. baccatus* Sowerby, 1889, are present in the BMNH (reg. no. 1889.2.1.12). One of these, a specimen with a colour pattern of numerous small spots, is clearly the figured specimen. It is here refigured and designated lectotype (Figs 103–105); dimensions, length 9,0 mm, diameter 11,6 mm.

Yen's (1942) discussion of the type material of *Trochus cariniferus* is thoroughly confused and is not consistent with my own observations on BMNH types. The type material of *Turcica concinna* A. Adams, 1863, which Yen stated comprised three specimens of *Trochus cariniferus*, actually consists of one specimen, the "possible holotype", which is chilodontine and shows no resemblance to *T. cariniferus*. Undoubtedly Yen must have had the types of *Polydonta (Infundibulum) concinnum* A. Adams, 1855, in mind, of which there are indeed three (syntypes) present in the BMNH (reg. no. 1967619). One is here figured and designated lectotype (Figs 106–108); dimensions, diameter 13,5 mm, length 11,5 mm.

Type locality: With no provenance accompanying either the original figure or the BMNH types, I here designate Mozambique Island as type locality for *Trochus cariniferus*. The species is common on this region of the Mozambique coast and the island is known to have been a source of East African shells collected during the nineteenth century.

Remarks: *T. baccatus* Sowerby, 1889, is here synonymised with *T. cariniferus*. The specimens in the type series of *baccatus*, though small (maximum diameter 13,5 mm), are all morphologically and sculpturally indistinguishable from the *concinus* form of *cariniferus*. The lectotype of *T. baccatus* has an aberrant and rather eye-catching colour pattern in which the typical reddish axial flames of the early whorls become fragmented on later whorls, remaining only as isolated flecks on the spiral cords (Figs 103–105). The paralectotypes are simply purplish-brown specimens of the *concinus* form.

Polydonta (Infundibulum) concinnum A. Adams, 1855, is also here synonymised with *T. cariniferus*. The types appear never to have been figured previously, but examination shows them to be examples of the greenish, granular form of *cariniferus*. At first sight these specimens would seem separable from typical *cariniferus* – they are more coarsely granulate, are patterned with dark green and



Figs 103–108. Junior synonyms of *Trochus cariniferus* Beck in Reeve, 1842. 103–105, *Trochus (Infundibulum) baccatus* Sowerby, 1889, lectotype, length 9,0 mm, diameter 11,6 mm; 106–108, *Polydonta (Infundibulum) concinnum* A. Adams, 1855, lectotype, length 11,5 mm, diameter 13,5 mm.

have more numerous, finer spiral lirae between the spiral cords. However, shell shape is identical and intermediates in sculpture and colour pattern are not infrequent. Populations in Mozambique contain both forms, but whether colour form can be linked to diet or microhabitat remains to be established. *Polydonta* Schumacher, 1817 is an objective synonym of *Trochus* (see above) and thus Adams' *concinnum* is secondarily homonymous with both *Trochus concinnum* Römer, 1841, and *Trochus concinnum* Philippi, 1846. However, in view of the synonymy with *T. cariniferus*, there is no need to provide a replacement name.

Trochus wilsi Pickery, 1989, is very similar to *T. cariniferus*, differing only in

details of colour and sculpture, which in any case are extremely variable in *T. cariniferus*. Whether this is worthy of specific distinction is debateable. If true *cariniferus* is absent from the Red Sea, as intimated by Pickery, then I believe *wilsi* should be regarded merely as a Red Sea form or subspecies of *cariniferus*. More material from the Red Sea and north-western Indian Ocean is needed to form a clearer picture of this issue.

T. firmus Philippi, 1849, described from the Persian Gulf, is more elevated, more evenly conical and thicker shelled. It has a relatively strong spiral cord just inside the umbilicus which stops short of the columella lip; the cord is frequently green in colour.

Etymology: *Carina* (L.) f. – a keel; *cariniferus*, *a*, *um* – bearing a keel.

Tectus Montfort, 1810

Tectus Montfort, 1810: 187, type species (o.d. fide Marshall, 1979) *Tectus pagodalis* Montfort, 1810 [= *Trochus mauritianus* Gmelin, 1791].

Pyramis (non Röding, 1798) Schumacher, 1817: 232, type species (monotypy) *pyramis* Chemnitz = *Trochus pyramis* Born, 1778.

Pyramidea Swainson, 1840: 350. Swainson listed a number of species under this taxon without specifying one as the type. I have been unable to trace a subsequent designation and here select *Trochus mauritianus* Gmelin, 1791, as type species of *Pyramidea*, thereby rendering it an objective synonym of *Tectus*.

Shells of species belonging to the genus *Tectus* resemble those of *Trochus*, but, though the columella may be disjunct, lack an umbilicus. Three subgenera are currently recognised (Keen in Moore 1960). In *Tectus s. s.* there is a strong keel on the columella, but in the subgenus *Cardinalia* this is lacking and is replaced by a small tooth on the columella, near its junction with the basal lip. *Rochia* Gray, 1857 (type species (monotypy) *Trochus acutangulus* Chemnitz = *T. conus* Gmelin, 1791), is somewhat intermediate between *Tectus* and *Trochus*; it has a smooth *Cardinalia*-like columella, but this is clearly disjunct at the paries.

Subgenus *Cardinalia* Gray, 1842

Cardinalia Gray, 1840: 147 [nom. nud.]; *idem*, 1842: 56, type species (s. d. Wenz, 1938: 309) *Trochus virgatus* Gmelin, 1791.

Tectus (Cardinalia) virgatus (Gmelin, 1791)

Figs 109–115.

Trochus virgatus Gmelin, 1791: 3580, N° 83; Lamarck, 1822: 19, N° 30; Deshayes, 1843: 135, N° 30; Philippi, 1846 (in 1846–55): 4, pl. 1, figs 4, 5; Reeve, 1861: pl. 12, fig. 69; Fischer, 1876: 97, pl. 27, fig. 1, pl. 28, fig. 1; Smith, 1879: 475; Caramagna, 1888: 126, 144; Hidalgo, 1905: 248; Kensley, 1973: 34, N° 53; Jouk & Revis, 1988: 38. Type loc.: given as India, but its occurrence there requires confirmation.

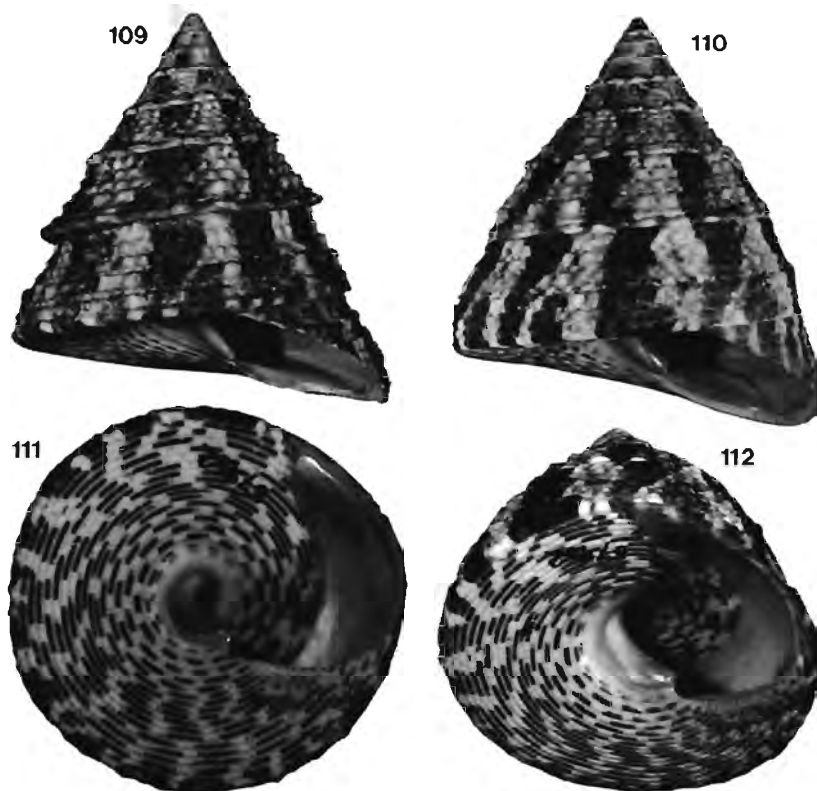
Cardinalia virgata; A. Adams, 1853: 151; Cooke, 1886: 264; Jousseau, 1888: 31; Shopland, 1902: 176.

Trochus (Cardinalia) virgatus; von Martens, 1880: 295; Pilsbry, 1889: 19, pl. 5, figs 43, 44; Baker, 1892: 34; Smith, 1903: 388; Sturany, 1903: 264; Lamy, 1909: 330; Oostingh, 1928: 6; Dautzenberg, 1929: 534(328); Bisacchi, 1931: 176; Paes da Franca, 1960: 56, pl. 2, fig. 1; Barnard, 1963: 253; Moura, 1972: 21, pl. 2, fig. 6.

Tectus virgatus; Kaicher, 1979: 2172; Sheppard, 1984: 46; Drivas & Jay, 1988: 34, N° 2; Herbert, 1991b: 4.

Tectus (Cardinalia) virgatus; Moura, 1966: 26, pl. 1, fig. 2; *idem*, 1969: 16; Kilburn, 1972: 394; Mienis, 1982: 61.

Diagnosis: Shell trochiform, base concave, anomphalus; early whorls stellate; apical surface sculptured by granose spiral cords and axially patterned with crimson bands on a whitish ground; base with close-set, finely granular spiral cords with numerous spirally elongate crimson dashes; columella disjunction scarcely evident, columella with a single tooth-like angulation at junction with basal lip.



Figs 109-112. *Tectus virgatus* (Gmelin, 1791). 109, Durban, NMSA 1174, diameter 48,0 mm; 110-112, Seychelles, NMSA J7962, diameter 43,0 mm.

Description: Shell trochiform ($L/D = 0,85-1,25$), teleoconch frequently in excess of 8-9 whorls, but apical ones usually somewhat eroded; whorls flush and sutures not indented; spire profile usually evenly conoid, but sometimes coeloconoid apically and cytroconoid toward base; suture normally at periphery, but sometimes set just beneath periphery giving spire a pagodiform profile; periphery sharply angled, well below mid-whorl, frequently stellate on early whorls; base concave, anomphalous. Early teleoconch whorls missing or eroded in all available material, subsequent whorls spirally corded; cords granular from about fourth whorl onward; body whorl with 6-15 cords depending on overall size; coarseness of granulation variable within and between individual specimens; subsutural cord frequently stronger than others;

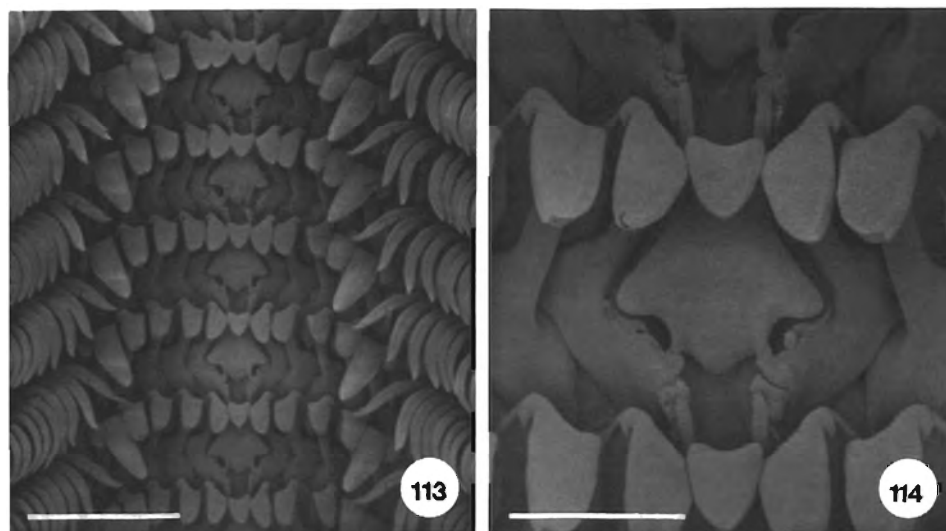
peripheral cord often drawn out into hollow stellations on early whorls; axial sculpture poorly defined, primarily of irregular collabral growth-lines; body whorl in fresh specimens sometimes retaining a thin brownish periostracum which appears as fine close-set axial pliculae. Base with 10–20 fine spiral cords; cords equal to or narrower than their intervals and sculptured by fine close-set granules; intervals with fine axial pliculae; central region of base covered with a smooth nacreous callus. Columella inserted just medial to parietal lip and columella disjunction scarcely evident; columella concave and oblique, ending basally at a distinct nacreous tooth in mature specimens; basal lip somewhat set back relative to columella, thin at aperture, but substantially thickened internally when mature, thickening sometimes denticulate; outer lip smooth, sharply angled where it meets the base; parietal lip at most very thinly callused and colour pattern of preceding whorl showing through; aperture subquadrate, nacreous, lacking ridges inside outer lip.

Protoconch: Missing in all available specimens.

Colour: Ground colour white, variously patterned with crimson axial bands; intervals between bands with very fine reddish zig-zag lines and not infrequently with flecks of green, sometimes quite heavily washed with green. Base with numerous spirally elongate crimson dashes on the spiral cords, generally with no axial pattern evident.

Dimensions: Largest NMSA specimen, length 75 mm, diameter 67 mm.

Operculum: Corneous; multispiral with a central nucleus; yellowish-brown to orange-brown; outer face frequently somewhat lustreless and set with numerous close-set oblique growth-lines; growing margin narrow.



Figs 113–114 *Tectus virgatus* (Gmelin, 1791), radula, ex NMSA E4660; 113, central field and inner marginals, bar = 300 µm; 114, rachidian and inner laterals, bar = 100 µm.

Radula (Figs 113–114): 60–70 transverse rows; formula $\infty + 5 + 1 + 5 + \infty$; essentially similar to that of *Trochus nigropunctatus*, but differs in a number of

noteworthy points; rachidian somewhat displaced posteriorly and indented in the mid-line; cusp smaller than that of laterals and lacking any secondary cusps; laterals elongate and asymmetrical, their tips somewhat pointed and curving upward; outer margin of each lateral with a single secondary cusp at junction of shaft and cusp, secondary cusps progressively larger from first to fifth laterals; fifth lateral with a particularly strongly developed secondary cusp beneath which the upper portion of the shaft is drawn out into an alate process. Basal interaction of teeth considerable, lateral expansion of frontal element of tooth shaft particularly well developed. Cusps of marginals more strongly and rather variably curved, usually with only a single inconspicuous denticle at junction with shaft. Base of innermost marginal tooth with distinct notch anteriorly, which articulates with alate process of fifth lateral.

External anatomy: Forehead wide with well-developed cephalic lappets; lappets joined in the mid-line, very wide laterally, but less so medially, free margin smooth or shallowly scalloped, not obviously papillate; cephalic tentacles prominent, but not large, micropapillate, base covered by cephalic lappet; eyestalks well developed, stout, basally confluent with cephalic lappet, eye subterminal, black; right post-optic tentacle not evident; snout broad, distally truncate and expanded ventro-laterally on both sides; oral disc D-shaped, lips split mid-ventrally; left neck lobe broadest anteriorly, tapering smoothly into epipodial fold posteriorly, anteriorly disjunct from eyestalk, margin smooth or at most roundly undulant; right neck lobe similar to left one but anteriorly fused to base of right eyestalk; underside of right neck lobe lacking

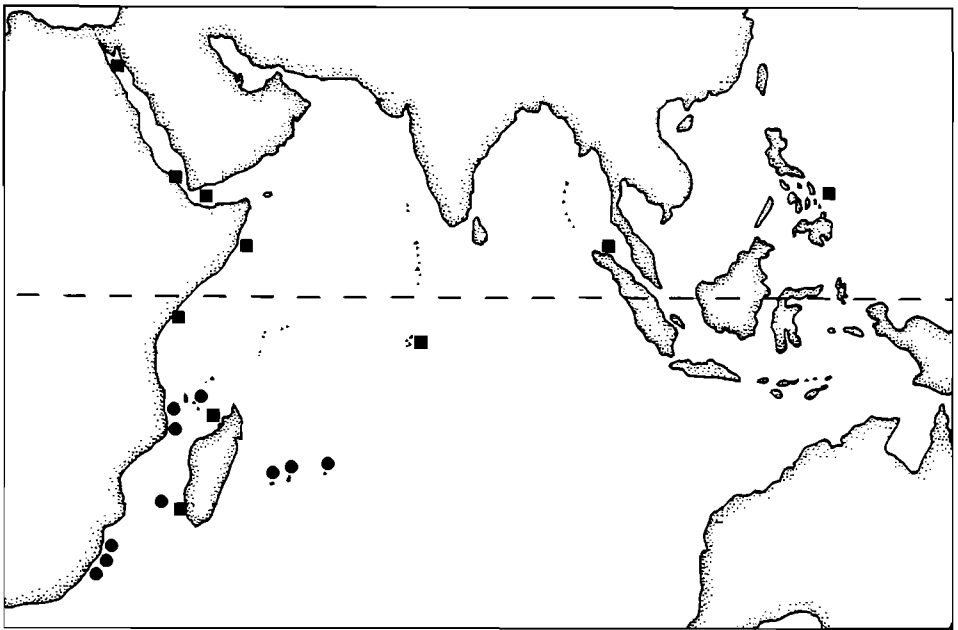


Fig. 115. Map showing the distribution of *Tectus virgatus* (Gmelin, 1791); black circles = material examined, black squares = literature records. Not indicated is an unlocalised record (in fact the type locality) from India.

a thickened ridge anteriorly (cf. *Trochus nigropunctatus*); no obvious epipodial sense organ beneath neck lobes. Epipodial fold expanded anteriorly into a rounded lobe (posterior to neck lobe); four micropapillate epipodial tentacles on each side, two beneath anterior lobe and two beneath operculum; epipodial sense organs present near base of each epipodial tentacle; epipodial fold continues posteriorly beyond operculum and joins in mid-line. Sides of foot pustulate; foot (in preserved specimens) truncated anteriorly, roundly tapering posteriorly; sole grooved longitudinally in the mid-line with numerous transverse folds; dorsal portion of foot posterior to operculum flattened and bearing a longitudinal glandular slit in the mid-line. Animal for the most part near white, but with some orange-brown pigmentation on head and sides of foot.

Ctenidium bipectinate almost throughout (only very short portion at posterior monopectinate), afferent ctenidial membrane long, extending well beyond junction of transverse pallial vessel, anterior $\frac{1}{4} - \frac{1}{8}$ of ctenidium free.

Distribution (Fig. 115): East Africa south to the Natal south coast, Madagascar, Red Sea, India (the given type locality), Indian Ocean Islands (Chagos, Comores, Mauritius, Réunion, Rodrigues and Seychelles), Indonesia (Oostingh 1928) and possibly also the Philippines (Hidalgo 1905).

The species appears to be an inhabitant of coral reefs and in south Africa it has only been found subtidally. In truly tropical areas it may also be found living intertidally on the reef crest or 'platier necrose' (personal observation, Rodrigues Is.).

Regional locality data (all NMSA, dead): ZULULAND: 'Kosi Bay', B. J. Young (B2609); between Bhanga Nek and Kosi Bay, N° 13 reef, 6–18 m, dived DH *et al.* (D9515); do, 9–14 m, dived DH *et al.* (S1673); do, ± 13 m, hand dredged sand, dived DH (S3078); Leadsman Shoal, main portion of reef, 7–11 m, dived DH & NPB (E2478). NATAL: Durban, H. Burnup (1174); Isipingo, W. Falcon (8938).

Extra-limital locality data (all NMSA): NORTHERN MOZAMBIQUE: Pemba, E. Roscoe (J9630); Conducia Bay, K. Grosch (H3839, H3840). COMORES: Sandy Is, Mayotte, E. Roscoe (G3643). EUROPA ISLAND: S. Dichmont (F6818). MAURITIUS: B. J. Young (H8541). RÉUNION: St Leu lagoon, sand, coral and stones, living, RK & DH (E4660); l'Étang-Salé les Bains lagoon, volcanic sand and coral, RK & DH (K5269). RODRIGUES: Between Anse aux Anglais and Pointe Venus, beach drift, DH (K7621). SEYCHELLES: Cerf Is. group and Anonyme, R. C. Wood (J7962, J7963).

Type material: The location of the type material of *Trochus virgatus* Gmelin, 1791, if still extant, is unknown to me. In the original description reference is made to figures given in Lister's *Historia Conchyliorum* (1685–92) and the *Conchylien-Cabinet* of Martini & Chemnitz (1769–95), but subsequent works detailing the known extant 'types' from these works make no mention of any specimens of *T. virgatus* (Wilkins 1953, Cernohorsky 1974). The figures given by Chemnitz (1781) [in Martini & Chemnitz 1769–95, vol. 5: 22, pl. 160, figs 1514–1515] were drawn from a specimen in his personal collection ("ex museo nostro") which was sold and evidently dispersed after his death.

Remarks: This species was first recorded from South African waters by E. A. Smith

(1903) based on a specimen collected by H. Burnup in Durban. Barnard (1963) questioned this, stating that the species had not been found subsequently in Durban Bay by the University of Cape Town or even in Delagoa Bay by the University of the Witwatersrand. Kilburn (1972), however, pointed out that the presence of the species in both Natal and Mozambique was well attested and cited additional locality data. Indeed, Burnup's original specimen is still extant in the Natal Museum collection.

Although very few specimens of this species have been found in Natal, recent expeditions to coral reef habitats in Zululand have brought in additional material. It is probable that local populations are maintained by larvae carried south by the warm currents flowing from tropical regions to the north.

Etymology: Virgatus, a, um, (L.) – striped.

ABBREVIATIONS

- BMNH – The Natural History Museum, London.
- DH – D. G. Herbert.
- L/D – Length (height): Diameter ratio.
- MNHN – Muséum National d'Histoire Naturelle, Paris.
- NMSA – Natal Museum, Pietermaritzburg, South Africa.
- NMDP – Natal Museum dredging programme.
- NMWC – National Museum of Wales, Cardiff.
- NPB – Natal Parks Board, Pietermaritzburg, South Africa.
- OUM – Oxford University Museum, Oxford, England.
- RK – R. N. Kilburn.
- USNM – National Museum of Natural History, Smithsonian Institution, Washington.
- ZMHB – Museum für Naturkunde der Humboldt-Universität, Berlin.
- ZMUC – Zoologisk Museum, Copenhagen, Denmark.

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